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Household Nutritional Effects of the DICONSA Food Subsidy Program

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Proposed Topic:

Household Nutritional Effects of the Diconsa Food Subsidy Program in Mexico

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Topic Characteristics

The Diconsa program was created in 1976 as a means to distribute basic commodities (corn, beans, rice, sugar, corn flour, powdered milk and tortilla products) at subsidized prices to marginalized populations throughout Mexico in rural stores. Diconsa products retail at prices on average 7%[1] lower than their open-market equivalents, a result of the Diconsa principle that transportation and operational costs are not passed on to the consumer.

The Diconsa program is essentially a government intervention in the private market for basic food commodities, providing a regulatory price anchor and increasing the targeted population's food security by means of increasing its purchasing power and by subsidizing staple foods. This targeted population consists of rural households in highly marginalized areas, where prohibitive operating costs prevent the establishment of a sufficiently competitive private market.

The aim of this thesis is to assess more precisely the program's contribution to what must be considered a fundamental motivation for its implementation – improving the nutrition levels in low-income households. This is potentially an informative analysis because substitution for less-nutritious foods has previously been empirically observed in the general case of decreasing relative prices, and in particular Jensen & Miller's study (2008) shows that there is no evidence for an increase in nutrition in the case of specific food subsidies for the very poor, and some for an actual decrease. Given the costs of maintaining food subsidies, I believe this is an important area of policy research.

I believe my study will provide a useful test of these results in a different setting, a different program, a different type of subsidy, and within a much larger and demographically

[1] PAR evaluación externa, 2006
[2] Data taken from FAO, 2012
[3] Data taken from World Bank 2011, 1999 figures.

more varied sample. This sample data is contained in the 2010 *Encuesta Nacional de Ingresos y Gastos de los Hogares* (ENIGH), or 'National Survey of Household Incomes and Expenditures', by the National Mexican Institute for Geography and Statistics' (INEGI). This survey is taken over 7 days from a random sample of over 27,000 households throughout Mexico.

Working hypotheses

1. The particular pattern of multiple commodity food subsidies provided through Diconsa does not significantly improve household nutrition levels amongst the targeted population of the rural poor in Mexico.
2. The consumer response to the subsidy is to alter diet composition without increasing the overall nutritional content of the household food basket
3. The subsidization of staple commodities results in significant income effects which increase overall household food consumption
4. Consumer response to the subsidy is at least partly dependent on specific household characteristics such as income and demographic composition

Methodology

The main body of this thesis will draw on econometric analysis of the Mexican household survey data. I will first have to establish a control group of households – non-participants – using the propensity score matching method. Participation is (initially) defined as the purchase of at least one food product in Diconsa during the week long survey. Specifically, what I will then be looking for is:

$$E(N_1^* - N_0^* | X, d = 1) = ATE_1$$

where N_0^* and N_1^* are the level of nutrition with and without treatment respectively, d is the dummy variable for Diconsa participation. X is a set of control variables, such as household income, etc, which is determined by the propensity score matching method.

The propensity score is essentially a probability, for a given household, of participation in the Diconsa program given the set of X variables. I match treatment households (participants) with control households (non-participants) according to propensity scores – matching like with like. I am then able to compare the two groups in order to see whether Diconsa participation has a statistically significant effect on nutrition levels once the X variables are controlled for, and to determine the sign of this effect – whether it is positive or negative.

I will then attempt to confirm my results by carrying out a number of robustness checks. This will involve modifying the set of X variables, as well as restricting the control group to households located in municipalities without a Diconsa store and comparison with OLS regressions with varying specifications at the household and municipal level. If the robustness checks fail, I will attempt to explain which significant unobservable characteristics might be absent from the data.

Given the methodological approach, I will also be able to identify which of the X variables – income, etc – are most important in determining participation, and, by looking at different propensity scores, I will be able to ascertain how the nutritional effect of participation (be it positive or negative) varies with different X characteristics. Furthermore, the detailed food expenditure data contained in the survey will allow me to uncover the specifics of the consumer response to the subsidy program and the degree to which it occurs.

Provisional Outline

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Potential Sources

Alderman, H. and von Braun, J.,"The Effects of the Egyptian Food Ration and Subsidy System on Income, Distribution and Consumption", International Food Policy Research Institute (IFPRI), 1984

Becker, S.O. and Inchino. A., "Estimation of Average Treatment Effects based on Propensity Scores." The Stata Journal 2(4):358-377, 2002

Conniffe, D., Gash, V. And O'Connell, P.J., "Evaluating State Programmes: "Natural Experiments" and Propensity Scores", The Economic and Social Review, Vol. 31, No. 4, October, pp. 283-308, 2000

Cunha, J.M., "Testing Paternalism: Cash vs. In-kind Transfer in Rural Mexico". Stanford University, 2010

Currie, J. and Gahvari, F., "Transfers in Cash and In-Kind: Theory Meets the Data", Journal of Economic Literature, 2008

George, P.S., "Costs and Benefits of Food Subsidies in India" in *Food Subsidies in Developing Countries: Costs, Benefits, and Policy Options,* Per Pinstrup-Andersen (ed.) John Hopkins Press, 1988

Gundersen, C., Yañez, M., Valdez, C. and Kuhn, B., “A Comparison of Food Assistance Programs in Mexico and the United States” Food Assistance and Nutrition Research Report No. 6., 2000

Herbert, L., and Scandizzo, P., “Food Distribution and Nutrition Intervention: The Case of Chile” Staff Working Paper 512. Washington, D.C.: World Bank 1982

Jensen, R.T. and Miller, N.H, “Do Consumer Price Subsidies Really Improve Nutrition?” CID Working Paper No. 160, 2008a

Jensen, R.T. and Miller, N.H, “Giffen Behavior: Theory and Evidence” Faculty Research Working Papers Series, Havard JFK School of Governance, 2007

Pinstrup-Andersen, P. "The Social and Economic Effects of Consumer-Oriented Food Subsidies: A Summary of Current Evidence" in *Food Subsidies in Developing Countries: Costs, Benefits, and Policy Options,* Per Pinstrup-Andersen (ed.) John Hopkins Press. 1988

Pinstrup-Andersen, P.,“The Effectiveness of Consumer-Oriented Food Subsidies in Reaching Rationing and Income Transfer Goals” in *Food Subsidies in Developing Countries: Costs, Benefits, and Policy Options,* Per Pinstrup-Andersen (ed.) John Hopkins Press. 1988

Rogers, B.L., “Design and Implementation Considerations for Consumer-Oriented Food Subsidies” in *Food Subsidies in Developing Countries: Costs, Benefits, and Policy Options,* Per Pinstrup-Andersen (ed.) John Hopkins Press, 1988

Rogers, B.L., “Pakistan's Ration System: Distribution of Costs and Benefits:” in *Food Subsidies in Developing Countries: Costs, Benefits, and Policy Options,* Per Pinstrup-Andersen (ed.) John Hopkins Press. 1988

Sahn, E. and Alderman, H., “On the Determinants of Nutrition in Mozambique: The Importance of Age-Specific Effects”, Elsevier Science Ltd 1997

Senauer, B. “Household behaviour and nutrition in developing countries” in *Food Policy*, vol. 15, issue 5, pages 408-417, 1990

Tritah, A., “The Public Distribution System in India: Counting the poor from making the poor count” GREMAQ, Universit´e des Sciences Sociales, Toulouse, France, 2004

Universidad Autónoma Chapingo (authors not cited), “Evaluación Externa Programa de Abasto Rural, Diconsa 2006”, Universidad Autónoma Chapingo, Unidad Gestora de Servicios Tecnológicos, 2007

Valdis, A. “Explicit versus Implicit Food Subsidies: Distribution of Costs” in *Food Subsidies in Developing Countries: Costs, Benefits, and Policy Options,* Per Pinstrup-Andersen (ed.) John Hopkins Press, 1988

ABSTRACT

This thesis is an empirical research project assessing the household nutritional impact of the DICONSA food subsidy program in Mexico. By employing a combination of propensity score matching and OLS econometric approaches, I conduct an analysis of household survey data contained in La Encuesta Nacional de Ingresos y Gastos de los Hogares (ENIGH) from Mexico. I find strong evidence of a significant increase in household caloric intake in rural areas targeted by the program, driven primarily by increased consumption of DICONSA subsidised cereal products and corn grain in particular. I find no evidence of decreased caloric intake resulting from overriding income effects of subsidisation. However, my investigation into the specifics of participant household food expenditure data suggests that reselling of subsidised commodities may occur amongst poorer households.

DECLARATION

I hereby declare that this thesis is my own work, based on the sources and literature listed in the appended bibliography. The thesis as submitted is 107,840 keystrokes long (including spaces), i.e. 64 manuscript pages.

Felix Dent

In Prague, May 18, 2012

Signature

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1) <u>Introduction</u>

1.1 Motivation

From January 2000 to January 2012, food prices across the world increased by over 220%[2], doubling in the space of three years between 2005 and 2008. The underlying economic reasons behind this unprecedented spike are layered and diverse, although a commonly identified culprit is greatly increased demand for industrial biofuel (Lustig, 2009). In the immediate future at least, the implications for the poorest people in developing countries are potentially serious, and the food security of many of these vulnerable populations looks increasingly in jeopardy (Lustig, 2009). It is at such times that the effective functioning of social safety nets is crucial, with the prevention of widespread hunger being a fundamental policy objective, particularly in developing countries. Depending on a particular country's geographic, social and economic situation, these nutritional safety nets may take many forms, from relatively simple conditional cash transfers to precisely targeted nutrition programs for children. The majority, however, work on the assumption that consumer behaviour can be positively influenced, in terms of nutritional intake, by some combination of 1) increasing overall purchasing power in target populations, 2) increasing supply in target areas and 3) providing incentives for consumption of particular types of foods – specifically those with greater nutritional benefits. Food subsidy programs, an important component of food policy in numerous developed and developing countries alike, are an example of a policy strategy that attempts to ensure food (nutritional) security amongst target populations by combining, in varying degrees, all three approaches listed above. Countries like Egypt, Morocco, Tunisia, Iran, India, Pakistan, Bangladesh, the Philippines, Venezuela,

[2] Data taken from FAO, 2012

Colombia and Mexico have all built up extensive distribution networks and administrative infrastructure dedicated solely to the provision of subsidised foods. The costs of these programs can be quite substantial, with Egypt, Iran and Morocco, for example, respectively allocating 1.7%, 2.7% and 1.7% of their entire Gross Domestic Products to maintaining these subsidises.[3] Given their prevalence, and the costs incurred, the question of whether these programs actually achieve their stated goals is an important area of policy research. Though these goals may be many and diverse, the improvement of the nutritional status of those at risk of malnutrition is an almost universal one, and it is in this area of study that this thesis, it is hoped, can make a contribution.

While the casual observer might see the question of whether the subsidisation of staple, nutritious foods directed at poor populations can indeed improve nutrition amongst these households as one that is universally answered in the affirmative and thus trivial, recent carefully-conducted studies have cast doubt on this most basic of assumptions (Jensen & Miller, 2008a, Kochar, 2005, Cunha, 2010). Even though the subsidy, appropriately targeted, amounts to an income transfer due to the associated increase in relative purchasing power, these studies found that the effect on caloric intake – one of many possible proxy indicators of nutrition levels - is ambiguous at best. One study (Jensen & Miller, 2008a), conducted in China, found the provision of staples at subsidised prices to extremely poor households had a *negative* effect on caloric intake, due to certain interactions of consumer behaviour at the microeconomic level. These findings have potentially major policy implications, as a mere increase in purchasing power is not enough to justify food-based safety net interventions, once we consider that cash transfers can achieve essentially the same goal. This thesis thus attempts to investigate the change, or lack

[3] Data taken from World Bank 2011, 1999 figures.

thereof, in caloric intake observed in the target households of what is an interesting example of a food subsidy program, the Diconsa program in Mexico. This program was chosen for this research for three reasons: a) while other food programs in Mexico have been the subject of empirical studies, the Diconsa program, to the best of my knowledge, has not, b) the Diconsa is an interesting case, combining geographic targeting with multiple but non-uniform subsidies without restrictions on the quantity purchased, and c) the high quality household survey data that is available from Mexican sources. This last point is important, as this study is carried out using various econometric techniques which are dependent on a rich source of data. Using these techniques in this alternative setting, it is hoped that further empirical evidence can be found, either supporting or contradicting the results of the studies mentioned above. Such evidence could potentially be informative in devising related policy interventions in the future, to the benefit of those most in need - this concisely summarises the wider motivation for this thesis.

1.2 The Diconsa program in rural Mexico

The Diconsa food program was originally created by the Mexican government in 1972 to distribute basic food commodities such as corn, beans, rice, sugar, corn flour, powdered milk and tortilla products at subsidised prices to marginalised rural populations throughout Mexico.[4] Retail outlets were established in target locations, supported by a wholesale procurement and transport network. By 1976, there were 1,500 Diconsa stores in operation, and by 2006 this number had increased to 22,312.[5] Today, there are 23,711 stores[6] in approximately 21,200 communities, of which 4,000 depend on Diconsa outlets as their only food commodity retailer.[7] The supporting infrastructure comprises some 7,700 workers, 28 central warehouses, 270 rural warehouses, 35

[4] Data taken from Gundersen et al, 2000
[5] Data taken from Diconsa PAR reporte final, 2006
[6] DIconsa (Dicrectorio de Tiendas), 2010
[7] Data taken from Chora, 2011

administrative offices and a fleet of 3,500 vehicles.[8] In addition to providing subsidised commodities to marginalised rural localities, the Diconsa network is integrated with government subsidised in-kind transfer programmes such as Liconsa (providing powdered milk directly to poor households) and the conditional cash transfer programme *Opportunidades*. This thesis, however, will be concerned only with *El Program del Abasto Rural* (The Rural Supply Program) or PAR, which refers specifically to the provision of subsidised commodities for retail rather than direct transfer. PAR has been in operation under its current name since 1979.

The underlying motivation for the Diconsa programme is stated in Mexico's National Development Plan 2007-2012 (Strategy 3.1): ensuring that "all Mexicans in poverty can cover their food, housing, basic services, education, and health necessities." Slightly more specifically, Diconsa seeks to 1) improve the nutrition of Mexicans living in rural communities in order to promote family development and 2) supply complementary, basic yet high-quality products at a low price to those localities most in need, in an efficient and timely fashion.[9] These - clearly related - goals are formulated in response to the failure of the private market to provide cheap food to poor households in isolated rural communities (Fox, 2007). A lack of infrastructure and the resulting high transportation costs, combined with a relatively low population density which reduces the incentive for new enterprise and thus competition, means that these households are subject to higher food prices than other areas where the basic food commodities market is more competitive and less costly for retailers. Hence the intention is to intervene in the private sector and provide a regulatory price anchor in the market for these commodities, increasing the targeted population's food security by means of increasing its purchasing power. Internal and

[8] Chora, 2011 (See Appendix II)
[9] Diconsa, 2011

external evaluations have since confirmed the 'pro-consumer impact' of the program, at least with regard to the purchasing power objective (Fox, 2007).

As outlined by Victoria Chora (2011), director of development with Diconsa, selection of localities for Diconsa intervention is dependent on two primary criteria: 1) the community's population must be less than 2,500 inhabitants, and 2) the locality must have a 'very high' or 'high' index of marginalisation as determined by the National Population Council (CONAPO). According to the PAR external evaluation of 2006, there are 23,707 localities that qualify under these criteria and an additional 7,566 which are said to qualify under special circumstances. Of the total 31,314 localities (37 million people), 16,827 localities (17 million people) already possess at least one Diconsa store – a programme coverage of 53.7% if we restrict ourselves to the target populations as defined. The establishment of a Diconsa outlet in a given locality is not strictly one for government authorities, however, but rather one that is taken on the basis of public demand for a store. Thus, a locality could theoretically fulfil the eligibility criteria and yet not require a Diconsa store, most likely because a competitive, low-priced private market for food commodities is already present. Data from the same study reveal that – in 2006 – roughly 85% of Diconsa stores are located in target locations as defined under the strict criteria or in locations qualifying under 'special circumstances'. Also worth noting is that 23% of localities of high marginalisation have at least one Diconsa store, while the same can be said of 9% of localities of very high marginalisation (2006 data). The reason for this imbalance is not clear in the absence of more detailed data at locality level. It is possible that a higher percentage of the former group are rural localities, although household survey data suggests the opposite, with 93% of households in the very highly marginalised group found in rural localities (less than 2,500 inhabitants) versus 79% for the highly marginalised. What seems most likely is that the isolation of the very poorest communities makes it difficult for even government-maintained distribution networks to reach them.

Today, the list of products sold in Diconsa stores numbers some 200 commodities, including cereals, sugar, oil, vegetables, meat, fish, dairy and various drinks as well as certain non-food items such as kerosene, soap and toilet paper. There is an emphasis on high nutritional content throughout the food product base. Although all products are not sold at all stores, the minimum requirement for all Diconsa outlets is that they provide what is known as 'Diconsa's basic basket': a selection of 21 basic, non-perishable items including corn, wheat and corn flour, rice, beans, sugar, cooking oil and soap (full list in appendix, **Appendix I**). According to Diconsa's operational rules, this basic basket as provided in their stores must represent a saving of between 3 and 7% versus the equivalent basket as purchased from private retailers. The 2006 independent evaluation of PAR found the overall Diconsa versus private saving on the basic basket to be approximately 6% (PAR Evaluación Externa, 2006) although this is not evenly spread across the different commodities. A more detailed account of the difference in prices as obtained from survey expenditure data will be given in section **4**. It is important to note here that Diconsa prices are not fixed below market prices directly; Diconsa absorbs the transportation and operational costs involved in maintaining the distribution network and this saving is then passed onto the consumer. Also, Diconsa stores are not government-owned premises but are owned by the community or by private individuals who must abide by basic pricing and operational rules but are otherwise unconstrained. As a result, prices of Diconsa products may vary between different locations to a certain degree. Apart from a significant dip following the 2008 financial crisis, Diconsa's total sales have been rising steadily since 2004 – having declined markedly from 2000 - and in 2009 totalled some $737.5 million.[10]

1.3 Hypothesis and empirical questions

This thesis is an attempt to test a basic general hypothesis as well as a number of related, more specific hypotheses. The general hypothesis is as follows: *the establishment of subsidised Diconsa food outlets in targeted locations imparts significant nutritional benefits, in terms of caloric intake, to participant households*. This hypothesis is based on basic consumer demand theory, which assumes that consumption (quantity demanded) of a particular good will increase as its price decreases. Given Diconsa's commitment to reducing prices of staple food commodities through subsidisation, one might reasonably expect that increased consumption of these staples amongst those at whom the program is targeted would logically follow. In the review of previous studies that follows, however, the apparent rationality of this conclusion will be questioned. Subsidisation of appropriate food commodities is not as simple and straightforward a solution to the problem of undernutrition as it might initially appear.

Although the majority of the analysis that follows will be an attempt to test this primary hypothesis, there are a number of other interesting empirical questions that may also be answered in doing so. These questions, in the order that they are addressed, are as follows:

1) What is the caloric composition of a given household's typical food basket, and how does it change as income increases?
2) What is the basic relationship observed between food expenditure, income and caloric intake?

[10] Data taken from Chora, 2011

3) Is there are a significant caloric deficit amongst the poorest households in the ENIGH survey, thus justifying the Diconsa intervention on nutritional grounds?
4) What is the observed effect of the Diconsa intervention on specific goods in participant household's food basket in expenditure and caloric terms?
5) Is the food basket of Diconsa households as recorded by expenditure data likely to be a true reflection of actual household consumption?

Empirical results relating to the primary hypothesis and the above questions, the subject of section **4**, are generally presented as straightforward quantative estimates obtained through the various methodological approaches (section **4)** and are supplemented by more in-depth analysis with graphical depictions being used to illustrate where necessary.

1.4 Structure of this paper

This thesis deals specifically with the nutritional aspect of the Diconsa programme. The stated aim is to investigate in detail the nutritional impact of the programme at the household level, to try and first answer the question of whether this particular type of subsidy programme imparts significant nutritional benefits to participating households and if it does, to what extent and through which channels of consumer behaviour. To this end, I will be applying various econometric methods to data provided by the *Instituto Nacional de Estadística y Geografía* (INEGI, National Institute of Statistics and Geography) in Mexico. Specifically, I will be analysing the 2010 survey data on household income and expenditure contained in *Encuesta Nacional de Ingresos y Gastos* (ENIGH, National Survey of Household Income and Expenditure) 2010 as well as, to a lesser extent, that contained in the same survey of 2008. In what follows I will briefly outline the structure of this paper, so that the reader may more clearly follow the various empirical questions I will be addressing and the methodological steps that I will be taking in doing so.

I will begin, in the next section, by providing theoretical and empirical background giving a brief review of previous studies into general and specific aspects of food subsidy programmes and the implications for consumer behaviour. Here I will be reviewing a selection of more general studies before going on to look in more detail at more recent, technical studies which are particularly relevant to the present study both in terms of methodology and the particular questions that are being addressed.

Section **3** is dedicated to the methodology that I will be employing in attempting to answer the empirical questions that I put forward. As the majority of the data analysis is performed on the statistics and econometrics package Stata, it is necessary to clearly detail the models and assumptions behind my results, and to justify them where necessary. These results are then presented in Section **4**, where I shall also give my own interpretation of their implications within the context of the hypotheses I am testing. Robustness checks of results presented are also detailed in this section, followed by a conclusion (section **5**) in which the final contribution of the thesis is evaluated from a more general perspective.

2) Review of Previous Studies

2.1 General studies

Pinstrup-Andersen (1988b) identifies the two key goals of a typical food subsidy program as follows:

1) (To ensure that) all or certain groups of households have access to certain specified minimum quantity of staple foods at "reasonable" prices and…

2) …to transfer incomes to certain population groups through lower food prices or food stamps.

If we confine our attention to the Diconsa program, it is easy to see a commitment to these goals reflected in the program framework. As will be empirically confirmed in section **4** of this paper, Diconsa subsidies, passed on to the consumer through the mechanisms described in section **1.1**, are directed primarily at cheap and nutritious staple foods, specifically cereals and, in particular, corn products. Subsiding staple commodities in this fashion serves as an additional form of targeting over and above that which is achieved through the strategic location of Diconsa stores. Firstly, as Pinstrup-Andersen (1988b) points out, poor consumers spend a higher proportion of their income on food and thus will theoretically benefit more, proportionally, than richer consumers from subsidization of *any* food that is consumed in at least equal quantities by different income quantiles. This relationship can summarized in graphical and mathematical terms by what is known as an Engel curve, with a graphical representation in the Mexican case presented in section **4**. The effect is magnified, however, with the good specific subsidization of a staple commodity like corn. As many studies have recognized (Pinstrup-Andersen, 1988b Kumar & Alderman, 1988, Rogers, 1988a, Long & Brownell, 2010, French, 2003, Senauer, 1990, Zarazig & Adams, 1996), it is usually preferable to select staple goods for subsidization because of the extra sensitivity of the targeted group – the poor - to price changes in this commodity compared to richer consumers. More precisely, as Rogers (1988a) puts it, the good or goods selected should have high (negative) price elasticity of demand amongst the targeted group and zero price elasticity amongst other - usually higher - income groups. This means that the targeted group is likely to increase its consumption of the staple good as the price decreases, while the higher income groups will not adjust consumption, thus restricting the benefit of the subsidy to the former population. Ideally, this good is consumed in large quantities to begin with by the targeted group, and consumed less or not at all by the non-targeted (Rogers, 1988a). Such a good, in classical demand theory, is said to have negative income elasticity (its consumption decreases with income) and is termed an 'inferior good'. With the preceding reasoning in mind, it is clear that commodity-specific price-targeting is a cost-effective means for policymakers to skew the subsidy benefit in favour of those they are trying to help.

Note that the above description of consumer response to a price change assumes that the quantity of the subsidized good available for purchase is unlimited and is restricted to the effect on consumption of the subsidized good alone. This is not the full picture, however. It is important to distinguish here between the substitution effect of a subsidy and the income effect (Rogers, 1988a, George, 1988, Valdis, 1988, Kumar & Alderman, 1988), as the total benefit of a particular subsidy should be measured after both are taken into account. The substitution effect refers to the increase in consumption resulting from a decrease in price, as described above, while the income effect is the *relative* increase in income that results from having to spend less on a particular good to purchase the desired amount, thus leaving extra income free to spend on other goods, be they food or otherwise. If a subsidy on an individual commodity is *inframarginal*, that is, if its real value in quantity terms for a given household is less than the total amount that the household would consume in the absence of the subsidy, then the increase in total food intake is expected in theory to be confined to the income effect only (Rogers, 1988a, Kumar & Alderman, 1988). This is because the price at the *margin*, or the price of an extra unit of food above the usual amount, remains the same. In this sense, a rationing or food stamp scheme, where the quantity of a subsidized food that a single household may obtain may be inframarginal, is theoretically equivalent to an equally-valued cash transfer and any increase in caloric intake should be equal whichever form the subsidy takes, although there it is not entirely clear if this holds universally true in practice (Pinstrup-Andersen, 1988a). However, when, as in the Diconsa program, the quantity is (theoretically) not restricted, the household is likely to increase its consumption of the subsidized good *above* that which it would consume in the absence of the subsidy (Alderman, 1988, Rogers, 1988b). This is the substitution effect described in the previous paragraph. The two effects are not mutually independent, however, and subsidising a staple good without limits on quantities will usually have income effects as well as substitution effects – the consumption of other goods may increase (or decrease) at the same time due to the income effect. In summary, the price effect of a subsidy may be decomposed into two parts: the income effect and the substitution effect. It is necessary to take both these effects into account when considering the potential benefits of a subsidy.

Unfortunately, when it comes to demand for calories, or demand for a nutritious diet however it is defined, the components of a particular consumer's demand for food are not quite so simple. Senauer (1990) finds that income elasticity for energy (calories) exceeds that for food expenditure as a whole for both the urban and rural poor. As he puts it, these groups simply do not conform to what would be 'optimal' behaviour when it comes to maximizing caloric intake as extra income becomes available. The problem (though it perhaps should not strictly be called a 'problem') is that consumer demand for food is not a simple relationship between nutritional need, income levels and price. French (2003) recognizes that even if people know what constitutes the ideal nutritious diet, other considerations such as taste and variety can be just as important, or even more so. Similarly, Zazazig & Adams (1996), in their analysis of the Egyptian food subsidy system, suggest making a distinction between the utility of variety across the diet as a whole, the utility of taste of each specific food and the utility of energy (calories). Even at subsistence levels of income, there is no reason to assume that the latter utility is the only consideration. When combined with the income/substitution effect tradeoff outlined above, this has important implications for food subsidy programs which explicitly aim to improve nutrition through price manipulation, such as the Diconsa program. Because of the complex interaction of demand components, the targeted consumer response to the subsidy is not necessarily an automatic increase in consumption of the subsidized staple exactly proportional to the decrease in price as would be required for this type of price targeting to be ideally precise. In fact, the relative magnitude of income effects of a subsidy can often be quite significant, and the increased purchasing power of the targeted consumer can lead to their altering their diet composition by substituting away from nutritious foods towards those more desirable in terms of taste, or simply to add variety (Pinstrup-Andersen, 1988a, Kumar & Alderman, 1988, Xuguang et al, 1999, Senauer, 1990). The issue becomes even more complex when subsidies are applied to multiple goods as in the Diconsa case. The changes in diet composition can even be so extreme, amongst certain types of households, that the subsidy causes a decrease in caloric intake as the income effect overrides the substitution effect and causes a *decrease* in the consumption of the staple good that is subsidized – the previously elusive 'Giffen' behaviour (Jensen & Miller, 2008b).

The issues of calorie-adverse price effects of the subsidies detailed above are of direct relevance to the analysis contained in this thesis. However, there are other aspects of food subsidy programs which, although outside the scope of this thesis, are nevertheless interesting to consider and very relevant in a wider context. Three of these that will now be briefly covered here, all related to some degree, are geographical targeting, costs versus benefits and political considerations.

Conducting an accurate cost-benefit analysis of a food subsidy program is an extremely difficult task. Valdis (1988) makes the point that identifying the full range of economic implications of a given program for a country as whole is quite arbitrary. The most obvious cost is that of subsidizing the food staples themselves. But there are also the costs of maintaining the distribution network, administrative departments, staff, product packaging (in Diconsa's case) and numerous other expenditure considerations that must be taken into account. For programs like Diconsa, with nationwide coverage, these costs can be substantial. And while these particular costs may theoretically be accurately calculated, there are still others which may be quite significant and near impossible to quantify. Neoclassical economists, for example, argue that subsidies of specific goods have an adverse net welfare effect through their distortion of market prices, working on the assumption that a freely-operating market is necessarily pareto-optimal, i.e. that no one individual can be made better-off without making another worse-off (Kumar & Alderman, 1988, Jensen & Miller, 2008a). Related to this criticism is the fact that the market for food, particularly in poor rural areas, is a two-way system in that rural households are often producers – farmers - as well as consumers of food, and as a consequence the net effect on their welfare, nutritional or otherwise, of a decrease in prices of a staple crop like corn is not at all obvious (Senauer, 1990) and ultimately near-impossible to calculate accurately without hugely detailed datasets. On top of these, there are still further costs associated with imprecise targeting, or 'leakages'. Leakages occur when households that are not intentionally targeted by the programs receive some of the benefit, specifically by purchasing the subsidized food at cheaper prices. Although the benevolent policy-maker wants to provide food security to as many people as possible, there is also a need to ensure that the benefit is imparted only to those who need it the most, as otherwise costs can spiral out of control. There is therefore a trade-off to be made between narrow targeting and minimizing leakages at the cost of perhaps not reaching some of those most in need, and more unrestricted targeting to maximize coverage while risking leakages (Rogers, 1988a). While food stamps are an example of narrowly-targeted programs, in that household eligibility is assessed on an individual basis, the targeting criteria followed by Diconsa is an example of geographical targeting, where the identification of highly-marginalised, remote rural locations for the establishment of Diconsa stores is intended to restrict coverage only to those most in need, without requiring households to go through a time-consuming and possibly imperfect screening process.

Precise identification of the benefits of food subsidy programs is also problematic. Determining the effect on household consumption, or the effect on nutrition, as this thesis attempts to do is not straightforward in itself, but the measurement of certain other benefits presents a much bigger problem. Even assuming that significant nutritional benefits are indeed imparted by the program in question, it is quite another matter to assess the diverse economic effects realized through the channels of healthcare costs, labour productivity or social and human capital. Aside from this, there is also the political dimension to consider. Hopkins (1988) refers to the political motivations behind targeted programs, where food subsidies are means of garnering political support amongst certain populations. Whether this counts as a benefit or cost, or more exactly, which to whom, is open to debate. Hopkins also draws our attention to the other side of the political coin, where long-standing and far-reaching food subsidy programs can foster the 'myth' of a fundamental right to cheap food for every person, and any attempt to withdraw these subsidies is met with fierce popular opposition.

As we can see, the matter of the real net social value of any food subsidy program is one infused with numerous political and economic considerations and interactions, all-in-all too complex to be resolved in the near future with any degree of certainty. Small questions, however, like that with which this thesis concerns itself, may be reasonably expected to have identifiable answers, given the right data and the right methodology. Thus we now turn our attention to other, slightly more technical studies, which attempt to answer similarly ‘small-scale’ questions using concrete empirical data.

2.2 Recent Empirical Studies

Kochar, Tritah, Mckenzie, Wood et al & Cunha: Mexico & India

What follows is a brief review of the methods and results from five studies carried out by Kochar (2005), Tritah (2004), Wood et al (2010) Cunha (2010) and Mckenzie (2004). The research of Kochar and Tritah looks at the effects on caloric intake or food consumption (Tritah) of the Public Distribution System in India. In Mexico, Cunha compares the effectiveness of in-kind transfers versus cash transfers, while McKenzie attempts to answer the question of whether tortillas are a Giffen good (i.e. whether their price elasticity of demand is in fact positive), and Wood et al look at welfare effects for Mexican households of recent food price increases .

India’s Public Distribution System (PDS) distributes various staple food items (wheat, rice, oil), as well as basic non-food necessities such as kerosene, to the urban and rural poor at subsidized prices. Once a universal coverage program, since June 1997 it has been restructured in an attempt to target more efficiently households falling below the poverty line, and renamed the Targeted Public Distribution System. Households above this line are still able to access the program, but benefits in terms of price and quantity allocations are significantly skewed in favour of the poorer group (Kochar, 2005). Kochar exploits the policy shift and the corresponding shift in relative prices for the different groups to try and identify the precise real value of the income transfer of the subsidy for participants, and then includes the fitted values for the this regression in a second stage regression with caloric intake as the dependent variable in a two-stage least squares (2SLS), instrumental variable (IV) approach. He then interprets the coefficient of the subsidy value in the second stage regression as the elasticity of caloric intake with respect to the real magnitude of the subsidy. Using repeated cross-sectional data of approximately 76,000 households, he finds that the elasticity of caloric-intake is quite low, at 0.06 – 0.08. This implies that a 1% increase in the subsidy as calculated would result in only a 0.06% increase in caloric intake. Combined with the problem of low program uptake amongst the targeted households, the resulting increase amongst poor households (below the poverty line) amounted to a mere 31 calories per person per day.

Titah's paper also addresses the effect of the TPDS subsidy on household welfare, although he approaches the problem from a somewhat different angle. Rather than looking at caloric intake, he focuses instead on the increase in food expenditure share and the implied increase in food consumption that results from participating in a the TPDS program. This participation (or treatment) is defined, in a similar manner to this thesis, as a household having purchased at least one product from a PDS Fair Price Shop during the period of the survey. In his estimation of the effect, Titah employs what is known as the Propensity Score Matching method (PSM), which is the construction of a control group counterfactual on the basis of a binary logit or probit regression of the treatment dummy variable on various household characteristics. The resulting propensity score for each household is used as a gauge of its suitability as a counterfactual control against which the outcomes for treatment (participant) households can be compared. As this method is employed in this thesis also, it will be described in more theoretical and practical detail in the next section. The outcome variable which Titah is examining is the share of food expenditure in total expenditure, and he finds that the treatment households increase their food expenditure share regressively by income quantile. That is, the poorest increase their food expenditure share by 7.1%, while the less poor of the poor increase their share by 2.7%. Controlling for income levels and pre-treatment shares, he then estimates the increase in food consumption, and finds that the mean impact of the subsidy on food consumption is even greater than the value of the subsidy. He does not, however, go into the specifics of the diet composition or changes in overall caloric intake, as this thesis intends. Thus, the overall impact on food security in terms of the reduction of undernutrition remains unclear from the results, given the possibility of nutritionally-adverse shifts in diet composition due to the interaction of substitution and income effects described previously.

Cunha's study is an analysis of the relative effect on food consumption of in-kind transfers versus cash-transfers in the context of Mexico's *Programa de Apoyo Alimentario* (PAL), or Food Support Program. PAL consists of direct food transfers, in the form of a specially designed nutritious food basket, to poor households. Cunha wishes to ascertain whether this type of in-kind transfer actually serves to increase food consumption, caloric intake, or general nutrition when compared to an equal-valued cash transfer. This kind of research is especially valuable given the ambiguity of the exact difference between the two types of transfer implied by the theory of consumer demand outlined above, in particular when the PAL transfer is inframarginal in terms of total food expenditure, as is in fact the case. In his evaluation, he uses data collected from a randomised control trial conducted at program roll-out. Households were randomly selected from targeted villages and given either an in-kind transfer, a cash transfer (scaled up by Cunha in his estimation as the absolute value is slightly less) or no transfer. This type of trial yields the most accurate data possible, as the randomisation process automatically constructs a valid counterfactual control group (the group that did not receive the transfer), whose observable and unobservable characteristics are statistically expected to conform to those of the treatment groups prior to treatment (unfortunately, the same cannot strictly be said of natural experiment settings like those contained in household surveys). Thus the treatment effect is a relatively simple matter of comparing means between the two groups. After doing so, Cunha concludes that PAL in-kind transfers do not increase or decrease food consumption relative to equal-valued cash transfers. The overall effect on the two treatment groups is significantly positive in terms of food consumption, particularly in terms of cereals, fruit and vegetables, while being positive but not significantly different from zero in terms of caloric intake. Thus it appears once again that neither an increase in purchasing power, nor an increase in total food consumption, necessarily results directly in increased caloric intake.

The research carried out by McKenzie (2004) and Wood et al (2010) has a slightly different focus, but still very relevant to this thesis. Instead of looking at the welfare, expenditure or nutritional effects of specific subsidy programs, they are instead concerned with how demand for specific goods changes with price amongst different socioeconomic groups. McKenzie confines this analysis to corn tortilla products, an important staple in Mexico, while Wood et al take a broader look at the income and price elasticities of different goods in order that welfare effects of price changes may be better estimated. McKenzie uses the four ENIGH datasets running from 1994 to 2000, taking the 1995 peso crisis as a source of exogenous price variation from which to better calculate the price and income elasticities of tortilla products. He is specifically looking for Giffen behaviour in tortilla consumption, where income effects from a price increase actually cause a corresponding increase in the consumption of the good. Wood et al estimate a demand system for multiple goods (tortillas included) from cross-sectional variation within a single survey, ENIGH 2006, using a PIGLOG specification of the demand function. Overall, their combined results suggest that the Diconsa subsidisation of multiple staple goods could potentially induce a significant increase in caloric intake. McKenzie finds tortillas to be an inferior good (their consumption decreases with income) but not a Giffen good, with a (compensated) price elasticity condtional on demographic composition of the household of -0.831. Wood at al., dividing their sample between urban and rural poor and non-poor, find tortillas to have almost 0 (compensated) price elasticity at all income levels, implying that consumption levels are not sensitive to price changes once income effects are taken into account. The (compensated) elasticity estimates for other goods, however, are universally negative and significant, with cereals at -0.99 and meat at -0.41 for the rural poor subsample. The corresponding estimates of income elasticities for these two goods, for the same group, are 0.73 and 0.92. As the Diconsa program concentrates heavily on reducing the price of cereals, the most calorie-dense food group, these estimates make it reasonable to imagine an increase in consumption of cereals through combined substitution and income effects, and thus calories, amongst target households. The cross-price elasticities are not provided, however, and thus no definite conclusions can be drawn here.

Jensen & Miller

Of all the studies reviewed here, Jensen & Miller's (2008) paper, 'Do Consumer Price Subsidies Really Improve Nutrition?' is the most meticulous and relevant in terms of methodology and results respectively. This study is one of two related research papers from the same authors that use data from a randomized control trial conducted in China that takes the urban-poor - households on considerably less than a dollar per person per day - as the subjects of an experiment to examine the precise effects of a staple food subsidy on the caloric intake of treatment households. The total sample size was 1,300 households, selected from two regions in

China and randomized into control and treatment groups. For five months, the treatment households were issued a daily voucher entitling them to certain discounts (three different subsidy levels) on the primary staple good of the region in question, rice or wheat flour. Through detailed daily consumption diaries, and three in-house interviews, the authors were able to precisely estimate the relative increase in caloric intake between treatment and control households. Controlling for regional, time and other non-related effects, the authors found no significant increase in caloric intake in either region, and even a slight but significant *decrease* in the less poor of the two regions. This result was due, at least in part, to the behaviour that was the subject of Jensen & Miller's second paper on the same experiment, 'Giffen Behavior and Subsistence Consumption' (Jensen & Miller, 2008b), where they found that consumption of the staple in the less poor of the two regions conformed to the classic definition of a 'Giffen good', specifically that households decreased their consumption of the staple in response to the price decrease. Overall, Jensen & Miller's paper provide a benchmark for studies of this kind, given the well-controlled environment in which the study was carried out, the duration of the experiment and the availability of consumption rather than purchase data. With household survey data like the ENIGH, despite the vastly increased sample size, it is simply not possible to control for possibly numerous unobservable factors in this manner, or to extract such exact estimates. However, given certain assumptions and methodological approaches, it is hoped that the remainder of this thesis can provide at least a plausible account of the caloric intake effect of the Diconsa subsidy program.

3) Methodology

3.1 Description of data: estimating calorie counts

The *Encuesta Nacional de Ingresos y Gastos de Hogares* (ENIGH) surveys are conducted by the National Mexican Institute of Statistics and Geography (INEGI) every two years. Data is collected at household and individual level on demographics, employment and detailed expenditure and income specifics. Total sample size in 2010 was 27,632 households. Households are sorted into basic sampling units consisting of (mean) 13 households, which are then themselves grouped into larger units according to predefined geographic areas, referred to as 'sampling design strata', each containing (mean) 322 households. Each basic sampling unit is given a sampling weight according to that unit's importance in terms of the total Mexican population, which is integrated into the dataset and thus taken into account in estimating the appropriate OLS and matching models. Separate from this survey design stratification, each household is identified by its location within a particular municipality within a particular federal state. There are 2,438 municipalities in Mexico, making the average population per municipality approximately 45,000 people.

As part of the household expenditure section of the survey, each household is required to detail its daily expenditures on food items over a one week period. These food items are each identified with a code referring to a table of 242 different items divided into the following 14 categories: cereals, meats, fish, milk, sugars & sweeteners, milk and derivatives, tubers, eggs, vegetables, fruit, coffee, tea & chocolate, spices & condiments, drinks and other foods. In addition to these in-house expenditures, all expenditures on food consumed outside the home are also recorded, although the particular food item being purchased is not recorded. Expenditures on food for animals are recorded as a separate category. Included with each expenditure observation are the day of purchase, amount purchased (kg), form of payment and place of purchase. For the first time in 2010, 'Diconsa store' was listed as an option for this latter variable. This revision is crucial for the purposes of this thesis, as it allows the identification of those households which shop at Diconsa stores as well as the calculation of calorie counts and total expenditures of the household's Diconsa food basket. In 2010, 1,584 of the 27,632 total households purchased at least one food item from a Diconsa store. Selected characteristics of Diconsa versus rural households are displayed in **Table 1** below. As we can see, Diconsa households are relatively poor, with a mean income of $6.1 (Purchasing Power Parity 2010) per person per day, although this is still some way from the World Bank's threshold of $1 per person per day used identify the extremely poor, which make up 1.1% (321 households) of the total sample in this case. The vast majority are also located in rural areas, which is to be expected given the targeting objectives of the program. Given that 9% of the total sample (2,552 households) live on less than $4 a day and are located in rural areas, this would suggest that Diconsa is somewhat imperfectly targeted in terms of poverty, although it must also be recognised that this is not the sole targeting goal of the program, and also that the sample may not include those households in more remote areas. A mean of 2.4 for the 1-5 CONAPO index of marginalisation (1 being very highly marginalised) is also somewhat surprising, considering that Diconsa theoretically looks to target only high and very highly marginalised localities. A mean value of 3.6 for the formal education variable implies that heads of Diconsa households typically receive a secondary school education without attending university, which holds true for even the very poorest of the households in the sample (<$1 and <$2). Also worth pointing out is the higher proportion (36%) of indigenous households participating in the program compared to the proportion in the sample as a whole (14%). However, this is evidently due to the targeting criteria.

In order to estimate nutrition effects of the program, each of the 242 food items was given a calorie per kilogram value. This value corresponds to those contained in the Table of

Composition of Foods for Central America provided by the Institute of Nutrition for Central America and Panama and the Pan-American Organisation for Health (INCAP & OPS, 2007), which gives detailed nutritional information for a huge variety of different foods within 20 different categories. Despite this rich source of nutritional information, however, it must be pointed out that exact matches were not possible in a number of cases due to the relative lack of detail as to exact food types contained in the ENIGH. In these cases it was necessary to either select the median value of the calorie counts for all food items possibly corresponding to the less exact item as listed in the ENIGH, or to select the count of that item which was likely a much more common purchase. In the case of corn grain, for example, there is only a single item key listed in the ENIGH, although there are multiple types of corn. Here, the calorie per kilo count for white corn was selected, as it is by far the most common type of corn used for human consumption in Mexico.[11] However, as in the vast majority of these cases, the calories between the different types varied only very slightly and the distorting effect on the subsequent analysis of selecting one or the other would have been negligible. Care was also taken to select only the uncooked value for all food types (both cooked and uncooked were listed in the tables) as they are purchased, as the increase in water content resulting from boiling will often decrease calorie per kilogram counts significantly.[12]

After attaching the appropriate calorie counts to each food expenditure item, total caloric intake from each expenditure is obtained simply by multiplying the quantity purchased by the calorie count and total caloric intake for the household over the week-long survey period is obtained by summing these quantities. Here it is necessary to differentiate between food

[11] Agricultural Marketing Resource Center, 2011

[12] Note that this is *per kilo*, with the added weight of water, and does not affect the total nutrition for the household of the quantity purchased

purchased from outside sources like Diconsa stores, and non-monetary food expenditures, such as consumption from a household's own business or direct in-kind transfers to poor households such as those through the *Liconsa* program, which are included in the survey in a separate category. Due to the inherent difficulties of accurately estimating market prices and thus equivalent monetary expenditures for these items, as well as the fact that the focus of this thesis is on subsidies in a market framework, all total household nutrition (THN) values in this paper (with the exception of that in **Table 1** below) are those obtained solely from outside purchases. Of course, recognising that nutrition may come from consumption of food that is grown or produced by the household itself, the necessary care is taken to ascertain whether agricultural households are more or less likely to shop at Diconsa stores, as this would distort both matching and OLS estimates . Including the appropriate regressors in probit regressions in the latter part of the paper shows that these 'autoconsuming' types of households are not, in fact, either less or more likely to shop at Diconsa stores. Another key point with regard to the total nutrition estimates is the presence of outliers in the sample. Looking at the maximum calorie per person per day value of 75,110 for the Diconsa households in **Table 1**, for example, it is clear that this is not a realistic reflection of actual daily caloric intake. It is more likely that the household in question is purchasing large quantities of food for storage to be consumed over a much longer time period. The reverse may be said for the minimum value of 15 calorie per person per day. It is difficult, however, to adequately define what constitutes an outlier in this context, as detailed food *consumption* diaries are not kept. For this reason, and because of the logical statistical expectation that low and high outliers should be balanced across the sample, outliers are retained. Dummy variables for the frequency of food purchases for each household are also included in the econometric models to try and control for these outliers.

Up to this point, 'nutrition' has been used synonymously with 'caloric intake'. This is clearly a very simplified view of what nutrition really means, as a genuinely nutritious diet may be very different from a high calorie diet. There are many different dietary components that are necessary to stave off disease and ensure healthy phsyical development, and of these calories are only one. Moreover, calories come from different sources (fats, carbohydrates etc.) and the

` **Table 1: Characteristics of Diconsa vs Rural households**

	DICONSA					RURAL				
	# HH	**Mean**	Std. Err	Min	Max	# HH	**Mean**	Std. Err	Min	Max
Nutrition per person per day	1584	2518.9	3497.7	14.86	75110	4173	2162	2621.3	0	75110
Locality size *	1584	3.69	0.71	1	4	6123	4	0	4	4
Household (HH) population	1584	4.51	2.31	1	21	6123	4.3	2.21	1	21
Dollars per person per day	1584	6.08	8.46	0.19	156.3	6123	7.13	10.54	0.12	262.2
CONAPO**	1584	2.4	1.2	1	5	6123	2.65	1.28	1	5
Education of HH head***	1584	3.62	1.95	1	11	6123	3.73	2.02	1	11
Indigenous proportion	1584	0.39	0.49	0	1	6123	0.29	0.45	0	1

*1=City, 2=Small town, 3=Large town, 4=Rural **1=Very highly marginalisation, ... , 5=Very low marginalisation ***1=No schooling, ... , 12=Phd

restriction of one's diet to one of these particular nutrients is potentially hazardous to health. However, as a measure of energy content and thus essential to the prevention of undernutrition, a diet with sufficient caloric content is vital for those living in poverty. For this reason, the WHO and FAO both use caloric intake per capita as the primary measure of the food situation in poor countries. The degree and prevalence of caloric intake deficiencies amongst the poor in the ENIGH sample is summarised in the next section, where it is demonstrated that there is considerable scope for improvement in Mexico in this regard. Although it would have been possible to include all nutrients from the INCAP/OPS tables in this analysis, there is simply not enough space to do so. Therefore, this study follows Jensen & Miller (2008a), Kochar (2005) and Cunha (2010) in focusing on caloric intake as a proxy measure of nutritional benefit.

3.2 Estimating Treatment Effects

Restated for clarification, the primary hypothesis that this thesis seeks to test is that the Diconsa program imparts significant nutritional benefits, in terms of caloric intake, to participant households. The confirmation or rejection of this hypothesis is dependent on a sound estimation of what is known as the Average Treatment effect on the Treated, or ATT. Specifically, this is the difference, for the average Diconsa treated household, between total household nutrition (THN) with the subsidy and THN without the subsidy. The problem here with cross-sectional data like the ENIGH, however, is that the THN outcome *with* the subsidy is all that is observed for treatment households. The basic problem that is faced in testing this hypothesis then, given the type of data (non-experimental) that is being used, is constructing the counter-factual control group against which total household nutrition (THN) of Diconsa treatment households may be compared (Blundell & Dias, 2008). It is clearly not sufficient to simply define the control group as the rest of the sample, as THN is determined by multiple factors such as income, household size, wealth, demographic composition, rural or urban location, and others which are not necessarily evenly balanced between Diconsa treatment households and the rest of the sample, thus corrupting the estimate of ATT. Therefore, it is necessary to condition on these observable characteristics, working on the assumption that once these – possibly numerous - factors are controlled for, pre-treatment THN for observed Diconsa treated households corresponds to that of observed untreated households. This is called selection on observables, as opposed to unobservables, which, if present and confounding, are impossible to control for by their very nature without a fully randomized experiment setting. Hence, the three separate but related methodological approaches which are now outlined are essentially different means of constructing the counterfactual control group by conditioning solely on observable characteristics. These three approaches are as follows:

1) Robust OLS regression of total household nutrition (THN) on a binary Diconsa treatment variable and a vector X of selected control variables using the ENIGH 2010 dataset
2) Comparison of THN means of Diconsa treatment group and a control group selected by the PSM method, using the ENIGH 2010 dataset
3) Robust OLS regression of THN on an adjusted, municipal-level, exogenous Diconsa treatment variable and a vector X of selected control variables using an augmented ENIGH 2010 & 2008 dataset.

Of these three approaches, the first serves as a preliminary investigation into the determinants of nutritional intake at the household level, with the coefficient of the Diconsa treatment variable as an initial estimate of the ATT. The PSM method, by constructing an (identifiable) control group by conditioning on the propensity score, is taken as a more reliable estimate of the ATT and also allows further comparisons between the specifics of control and treatment outcomes. The third approach is intended as an estimate of the ATT in a wider context and a further robustness check, by constructing a treatment variable which captures the regional *intensity* of the program rather than a simplistic binary (yes or no) assignment to treatment at the household level. What now follows is a theoretical outline of these three approaches.

3.2.1 OLS regression with binary household-level treatment

In order to obtain an initial estimate of the treatment effect against which PSM and the augmented dataset regression can be compared, the following simple regression model is run on the ENIGH dataset:

$$\boldsymbol{THN_i} = \boldsymbol{\alpha} + \boldsymbol{\beta} * \mathbf{X_i} + \boldsymbol{\gamma} * \mathbf{Diconsa_i} + \boldsymbol{\epsilon_i}$$

where the i subscript indexes households, THN is total household nutrition calculated as described in section **3.1**, X is a vector of household-level control variables, Diconsa is a dummy treatment variable taking on the value 1 if the household in question purchased at least one product from a Diconsa store and 0 otherwise, and ϵ is the error term. The coefficient vector of variables in the X vector, β, serves to absorb the observable variation in the dependent variable THN that is determined solely by the various household characteristics in X such as demographic composition, geographic location and income, leaving the γ coefficient theoretically free to capture the effect of Diconsa treatment conditional on X. γ thus represents the desired ATT estimate – the change in household caloric intake due to Diconsa treatment.

This estimation of the treatment effect γ is treated as preliminary only for a number of reasons. Firstly, in addition to the other classical assumptions behind OLS models, it assumes that all regressors in the vector X are exogenous, that is, there is no two-way interaction between the right hand side covariates and the dependent variable THN: $E(\epsilon \mid X) = 0$. This assumption may not strictly hold for all regressors, as caloric intake can clearly influence certain household characteristics such as working hours. Secondly, the correct functional form (possibly including higher order terms) is not exactly known. Thirdly, estimation of the treatment effect using this method treats all observations in the sample as equally weighted in terms of calculating the ATT, resulting in a less precise estimate (Blundell & Dias, 2008). Finally, this method of estimation does not allow the identification of a specific control group, which will be necessary if further investigation is to be carried out into the channels of consumer behaviour through which the ATT is realized.

3.2.2 PSM matching

For the purposes of this thesis, the PSM method of estimating the ATT is preferred because it avoids these potentially confounding aspects of the simplistic OLS regression approach with our sample. PSM is used in economic policy evaluation for a variety of different outcomes in a variety of different settings, particularly where the ideal randomized control trial approach is not feasible (Tritah, 2004, Conniffe et al, 2000, Pufahl et al, 2009). PSM entails the identification of an appropriate control group within the sample by means of probit regression of the binary Diconsa treatment dummy on the determining X vector of observable household characteristics. This regression generates a set of coefficients corresponding to each variable within the X vector which allows the calculation of a propensity score for each individual household. This propensity score is a measure of the particular household's propensity to participate in the Diconsa program, i.e. to receive treatment, even if assignment to treatment is not actually observed. It is thus a function of X which represents the probability of treatment conditional on the particular observed values of the variables in X:

$$\boldsymbol{Pscore_i} = \mathbf{Pr}(\boldsymbol{Diconsa_i} = \mathbf{1} \mid \boldsymbol{X_i})$$

Once the propensity score is calculated, treatment households are then matched, using various algorithms, to an untreated household, or households, with a similar propensity score, which then serves as a control with which to compare the observed THN. The algorithms used for the matching process in this these are Kernel matching, Nearest Neighbor matching and Stratification matching.[13] The ATT is then taken as the propensity score weighted mean of all differences between treated households and controls. In this way, the equal weighting problem of the simple OLS model is overcome.

There are a number of theoretical assumptions behind the PSM method. Firstly, given the propensity score P(X), we have:

$$Diconsa \perp X \,|\, \mathrm{P}(X)$$

That is, *given the propensity score* P(X), theoretical assignment to treatment – the probability of purchasing at least one product from a Diconsa store – is independent of the observed values of the X vector (Becker & Ichino). This property is known as the balancing property and in practical calculations amounts to balancing the means of the different variables within the X vector between control and treatment groups. Another important assumption is that of unconfoundedness given the propensity score:

$$\boldsymbol{THN_1}, \boldsymbol{THN_0} \perp \boldsymbol{Diconsa} \,|\, \mathbf{P}(\mathbf{X})$$

This assumption is essentially the statement that, *given the propensity score*, Diconsa-treated households as observed would have the same non-treatment THN outcome as the observed non-treated households, and vice-versa. Note that this condition requires that the selected X variables simultaneously determine the outcome THN conditional on treatment, as well as the treatment

[13] For a fuller explanation of these methods, see Becker & Inchino (2002) or Blundell & Dias (2008)

variable Diconsa (Blundell & Dias, 2008). This, combined with the balancing property, allow the artificial counterfactual to be constructed from the ENIGH sample, with the ATT defined as follows:

$$\mathbf{ATT = E\ \{\ E\ \{\mathit{THN_{1i}}|\mathit{Diconsa_i}{=}\ 1, P(\mathit{X_i})\} - E\{\mathit{THN_{0i}}|\mathit{Diconsa_i}{=}\ 0, P(\mathit{X_i})\}\ |\ \mathit{Diconsa_i} = 1\}}$$

where the subscript 1 denotes treatment and 0 denotes no treatment, and E signifies expectation, in this case the mean value. For the investigation into differences in household behaviour that follows, the control group within the sample is then taken to be either the entire matched non-treated group using the Nearest Neighbour matching method, or a sample of non-treated households gathered around the treatment group propensity score mean.

3.2.3 OLS regression with adjusted Diconsa treatment at municipal level

Because the two methodological approaches described above depend on the identification of Diconsa treatment at the household level, both estimations of the ATT are obtained from the 2010 ENIGH dataset only, as it is the 2010 revision of the questionnaire that included 'Diconsa' as an option for 'place of purchase'. However, because purchasing an item in a Diconsa outlet is essentially a voluntary decision at the household-level, the estimates obtained from both approaches are potentially subject to distortion as a result of what is known as 'self-selection'. Self-selection occurs in this type of program because the decision to purchase subsidized food commodities - to assign oneself to treatment – may very well be the result of unobservable factors as well as observables. While the intention of conditioning on the X vector of characteristics is to attempt to remove variation in THN that is unrelated to the treatment, this cannot account for the self-selection effect if present. Thus, for this second OLS model, the treatment variable is redefined to capture an *exogenous* source of variation in the *intensity* of treatment:

$$\boldsymbol{Diconsa_{ijt}} =$$

$$\left(\frac{(\boldsymbol{Number\ of\ Diconsa\ stores\ in\ municipality\ j\ at\ time\ t})}{\boldsymbol{Number\ of\ Rural\ localities\ in\ municipality\ j}}\right)$$

$$* (\boldsymbol{Rural_i})$$

With the full model specification, for a household i in municipality j at time t, being:

$$\boldsymbol{THN_{ijt}} \ = \ \boldsymbol{\alpha + \beta * X_i + \gamma * Diconsa_{ijt} + \pi * Rural_i + \ \theta * Time_t + \ \epsilon_j}$$

Where $Rural_i$ is a dummy variable taking on the value 1 if the household i is located in a locality with a population of less than 2,500 people – the targeted locations of the Diconsa program – and $Time_t$ is a dummy variable taking on the value 1 if the household is from the 2010 survey and 0 if it is from 2008. Because the possibility of treatment within a municipality decreases with the amount of potentially eligible localities, holding the number of Diconsa stores fixed, the treatment variable is adjusted to represent the probability of there being a Diconsa store in a particular household's locality. This is necessary due to the nature of the dataset, where household-specific location is only recorded at the municipal level, although a variable denoting the size of the locality is included. To further conform to the Diconsa targeting policy, the adjusted treatment variable is next split into multiple parts with interaction terms, a time dummy household-level size of locality dummies and municipality-level marginalization dummies. The full specification thus becomes:

$$\boldsymbol{THN_{ijt}} = \boldsymbol{\alpha} + \boldsymbol{\beta} * \mathbf{X_i} + \left(\sum_{k=1}^{4} \boldsymbol{\gamma_k} * \mathbf{Diconsa_{ijt}} * \mathbf{Marginalization_{jk}}\right) +$$

$$\left(\sum\nolimits_{k=1}^{4} \boldsymbol{\delta_k} * \mathbf{Marginalization_{jk}}\right) + \left(\sum\nolimits_{k=1}^{3} \boldsymbol{\pi_k} * \mathbf{Locality\ size_{ik}}\right) + \boldsymbol{\theta} * \mathbf{Time_t} + \boldsymbol{\epsilon_j}$$

This specification allows the use of the augmented dataset without the need for household level identification of treatment, as well as taking into account possible self-selection bias at the household level by using an exogenous source of variation in the intensity of treatment.

While the three approaches outlined are utilized in the estimation of the ATT, I will also be looking more closely at various aspects of consumer behaviour within different income quantiles and between treated and control groups. The methodology behind most of this secondary analysis is relatively simple, and any minor points are made as the results are presented. All estimation and secondary analysis is carried out using Stata version 11.1.

4) Results

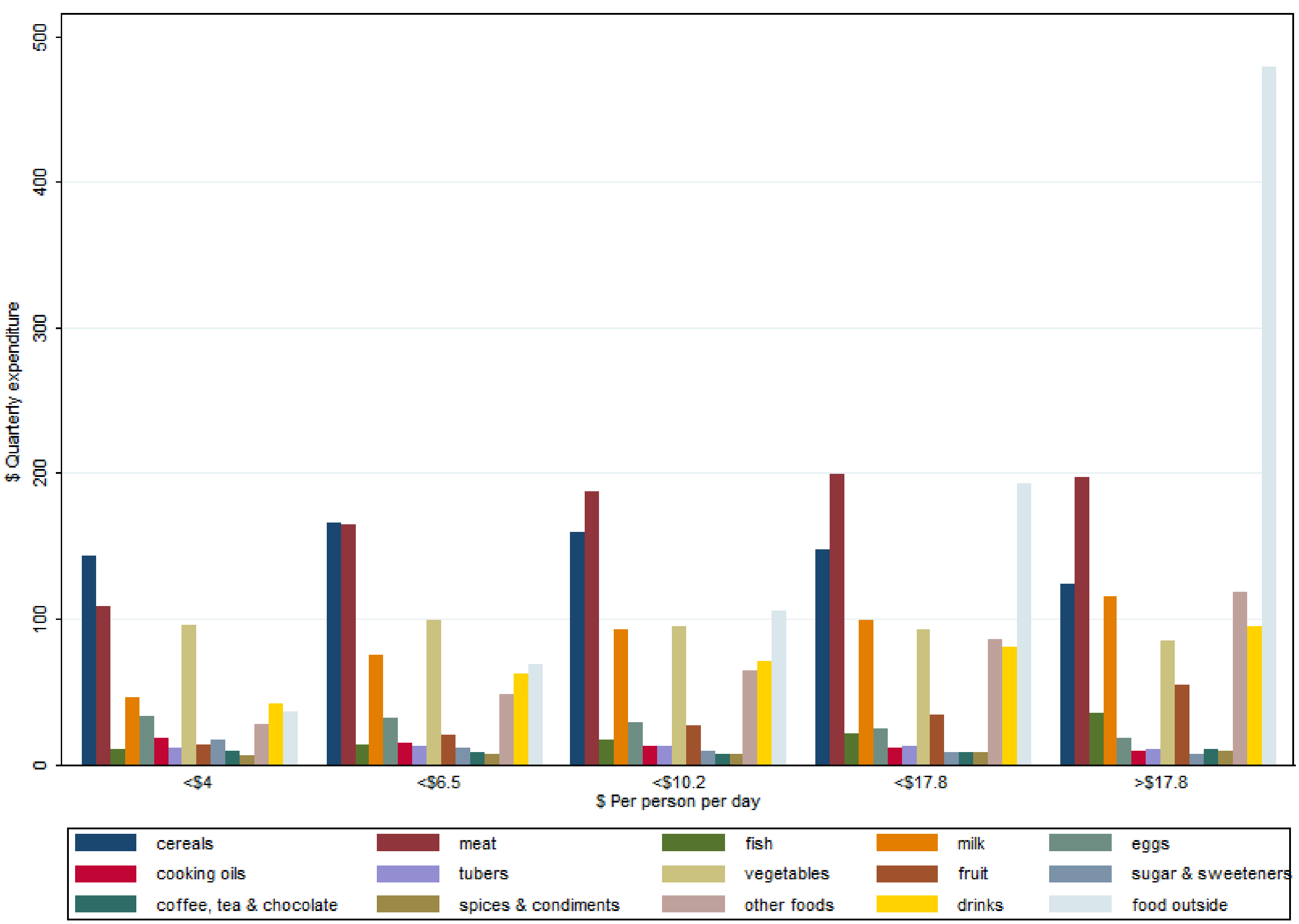
The empirical results of this thesis will be presented as follows:

1) Preliminary analysis of consumer demand behaviour and household caloric deficit in Mexico
2) Results of the basic OLS model using the ENIGH 2010 dataset with analysis
3) Results of PSM approach with analysis
4) Results of the adjusted OLS model with augmented ENIGH 2010 & 2008 dataset with analysis

4.1 Household Demand for Food

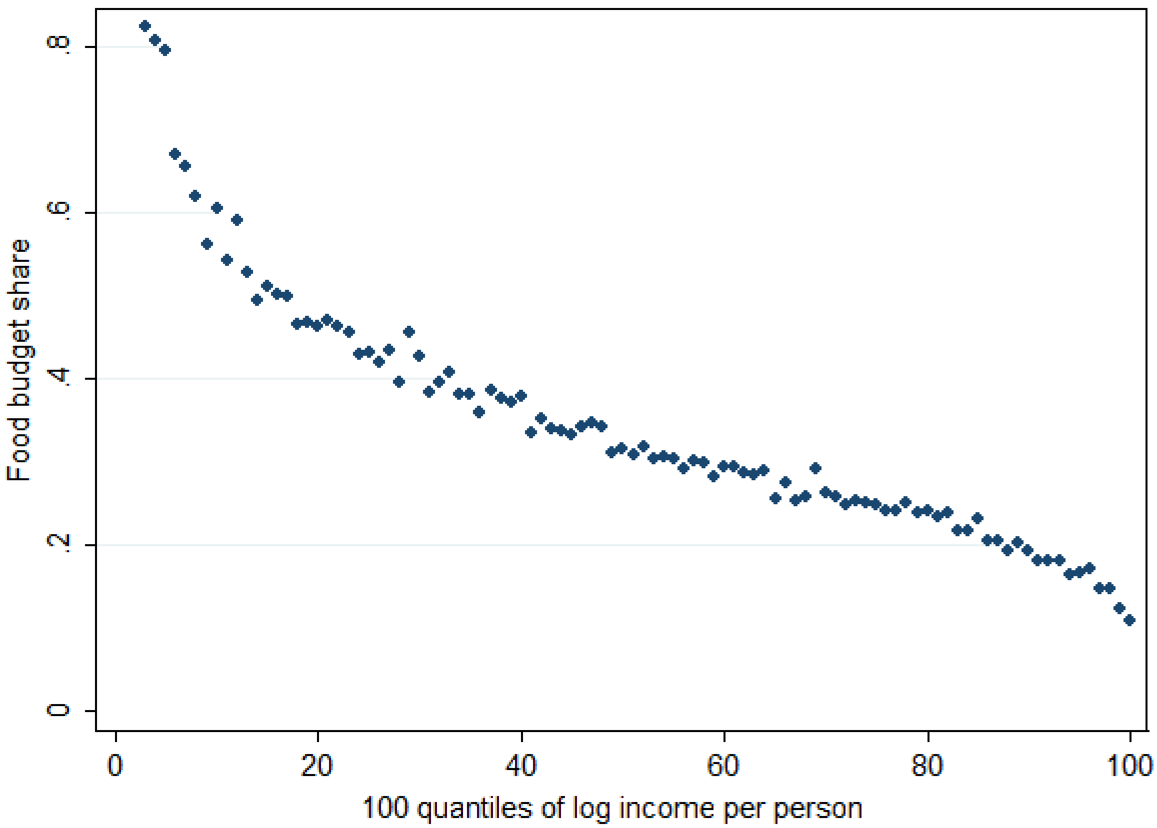
Before estimating the ATT, it is beneficial to attempt to paint a general picture of household demand for food in Mexico, in terms of expenditure and calories. **Figure 1** below shows the average food basket, in terms of expenditure, of households in the ENIGH sample as divided into five income quantiles of dollar income (2010 PPP) per person per day.

Figure 1. Food expenditure by income quantile



A number of trends are immediately evident. First, overall expenditure on food increases with income. The *proportion* of income spent on food, however, decreases with income. This relationship, known as the Engle curve, is more clearly depicted in **Figure 2.** Thus, the Diconsa program, and in general any food subsidy program, is always proportionally more beneficial to the poor if we view the subsidy solely as an income transfer.

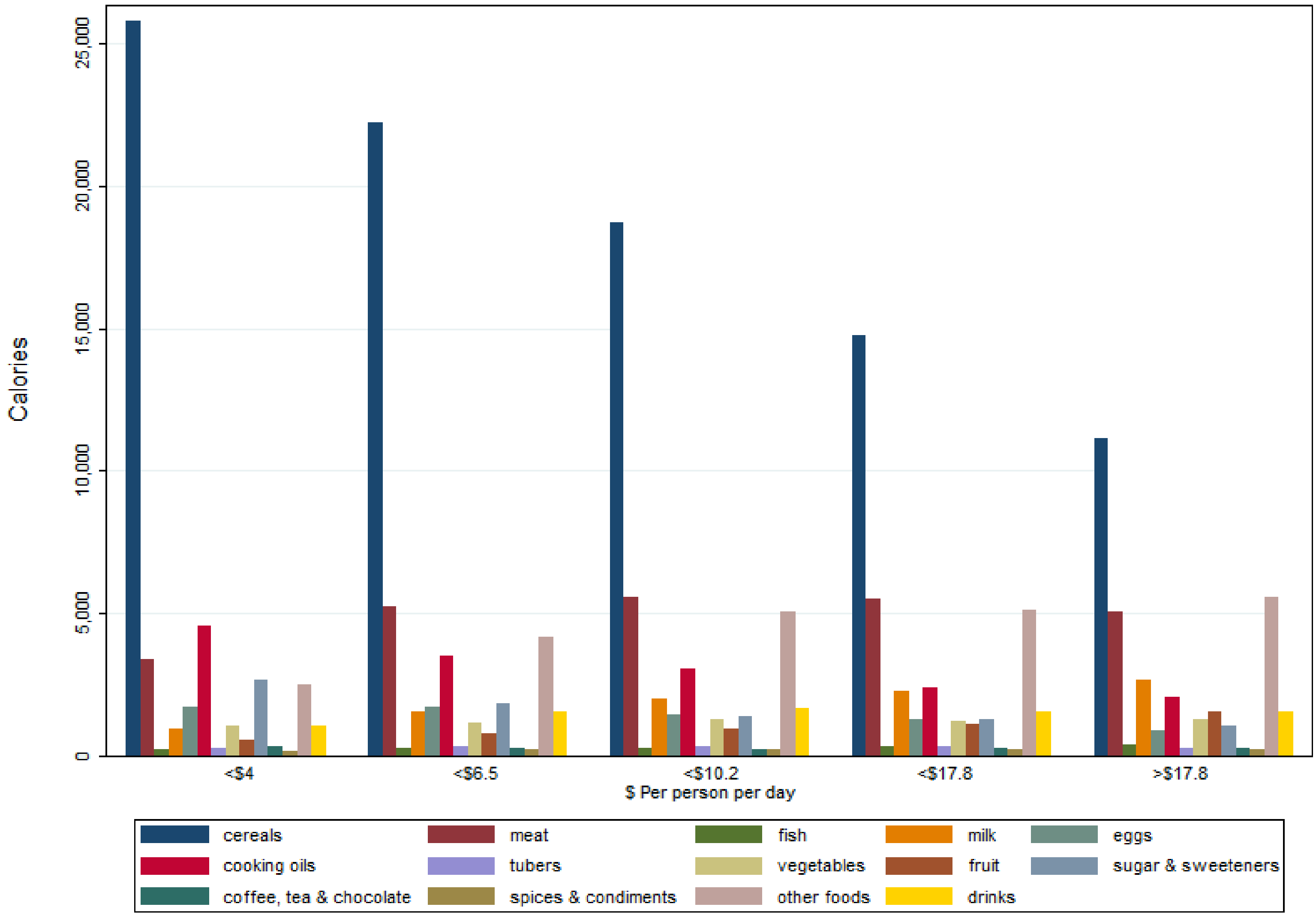
Figure 2. Engel curve – food share by income quantile



Secondly, expenditure on food consumed outside the house (food outside) increases rapidly with income. This is important for this analysis, as the exact caloric composition of outside food expenditure is not known and is thus excluded from THN calculations. Thirdly, the income elasticity of meat, milk, fruit, drinks and 'other foods' appears from this graphical analysis to be positive, with expenditure noticeably increasing with income. Vegetables, surprisingly, appear to be weakly inferior goods across the entire sample if we confine ourselves to in-house expenditure, but the unknown composition of outside food expenditure makes drawing any certain conclusions here impossible. The relationship between expenditure on cereals and income seems to be slightly more complex, with the maximum expenditure found in the second poorest quantile on less than $6.5 dollars per day (DPD). This has possible implications for the Diconsa program, given that the mean DPD of the Diconsa treated group falls within this quantile (**Table 1**). Overall, however, what stands out is the lack of over-reliance on a single or even two food groups, with substantial expenditure on cereals, meat and vegetables even in the lowest income quantile. This suggests that there is considerable scope for substitution amongst the different food groups, and thus the overall price effect of a food subsidy on the composition of the food basket is by no means certain.

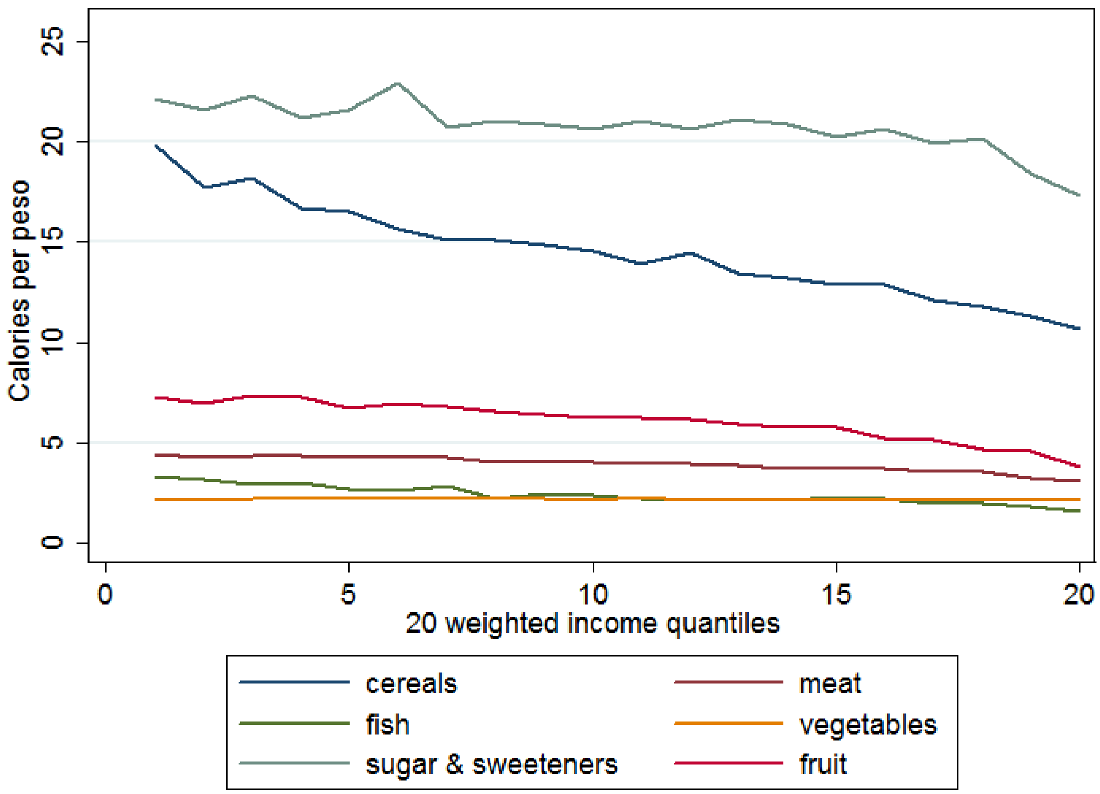
Figure 3 depicts the caloric composition of the food basket by the same income quantiles. Once again, it must be emphasized that the caloric composition of the outside food basket is unknown, and thus it is the relationship between expenditure and calories within the food groups that is most informative. The contribution of cereals to total caloric intake at lower income levels is clear, ignoring outside food expenditure, but it is not directly proportional to expenditure. This suggests that at lower income levels, households tend to substitute towards cereal types with high calorie counts, namely corn products such as corn grain, corn flour and corn tortilla, as well as rice grain to a lesser degree. **Figure 4** shows this relationship more clearly.. Consumers display an increasing tendency to substitute towards more expensive foods with desirable characteristics other than the amount of energy they provide, such as taste. These are the extra components of the food utility function described by Zazazig & Adams (1996) and French (2003), which appear to take on more importance as income increases. This is of course intuitively understandable, as subsistence concerns of the average household will naturally dissipate once above a certain income threshold. The trend is particularly pronounced for the cereals food group, although it is

Figure 3. Calorie baskets by income quantile



present in all groups with the exception of vegetables, whose nutritional value is not best represented by caloric content. This aspect of household behaviour supports the idea that food subsidy programs which seek to increase caloric intake should focus on calorie-dense, staple foods, with cereals (grains) being an obvious candidate.

Figure 4. Calorie per peso by income quantile



The aim of diet manipulation is primarily to increase caloric intake in order to reduce the incidence of undernutrition. If there is not initially a problem of undernutrition in the targeted region, however, this aim is rather redundant. Households are more likely to restrict their consumption of calorie-intensive foods to the minimum level required to fulfil caloric basic requirements, while using the remaining extra income to purchase foods more desirable in terms of other characteristics, to add variety to the diet or possibly to purchase other, non-food items. With this in mind, the caloric deficit of rural households surveyed in the ENIGH was calculated at different income levels, in order to ascertain whether the explicitly stated goal of the Diconsa program to improve household nutrition is justified. The caloric need was estimated by decomposing the demographics of each household into 12 different age/sex categories (Appendix **III**) and multiplying the total household population in each category by the corresponding recommended calorie intake per day value contained in the tables provided by the National Mexican Institute of Nutrition (INN, 1983). Total household nutrition per day, non-monetary expenditures included, was then subtracted from this value and divided by the total household population. Only households with zero outside food expenditure were included in the calculation, while Diconsa households were excluded. It must be noted that the estimate of caloric deficit as calculated by this method is extremely noisy – varying substantially - throughout the sample and hence this can be taken as rough approximation only without much more detailed data. The results in cumulative population terms are displayed in **Table 2**.

Table 2. Caloric deficits per person per day

$ per pers. per day	# Obs	Caloric deficit	t-stat
<$7	2367	**187.53**	4.5547
<$6	2135	**206.55**	4.7307
<$5	1822	**220.63**	4.701
<$4	1449	**227.05**	4.173
<$3	1000	**340.49**	6.4022
<$2	584	**377.05**	5.6168
<$1	162	**318.64**	2.7968

From these estimates, there is at least suggestive evidence of a significant and increasing caloric deficit amongst the rural population as we restrict ourselves to progressively lower income levels, although it appears to be substantially less than the >500 deficit found by Jensen & Miller (2008a) in their sample of the extremely poor in China. However, the particular distribution of the deficit amongst the household members may not be equal, which can compound the problem of undernutrition (Pinstrup-Andersen, 1988a). Thus it seems to be reasonable to suppose that there is at least some scope for improvement in caloric intake in the regions targeted by Diconsa.

4.2 Household-level OLS regressions

The results of the preliminary OLS regression with the binary Diconsa treatment variable are displayed in **Figure 5**, with various controls and robust standard errors. Diconsa treatment in this case is defined as the household purchasing at least one item from a Diconsa store over the period of the survey. The result is robust, however, to defining treatment as purchasing at least 10 items from a Diconsa store, or as purchasing at least two different items on different days, with the estimate actually increasing in both these cases. It is also robust to arbitrary specifications of the standard error and the weighting of the regression according to the survey sampling weights, as well as transformation into per-capita terms and log-log specification. The treatment effect estimate of a 13,397 increase in calories per household per week is approximately equivalent to 425 calories per person per day in Diconsa households. If accurate, this increase would on average be more than sufficient to overcome the caloric deficit in even the poorest households.

Figure 5. OLS regression of THN with ENIGH 2010[14] (source: author's calculations)

	Total HH nutrition				
Diconsa dummy	**-**	**13401.3*** (1530.4)**	**13379.5*** (1530.6)**	**13421.1*** (1525.1)**	**13397.9*** (1525.2)**
HH size	1693.4***	3155.7***	1693.0***	3180.2***	1685.4***
	(363.1)	(216.4)	(361.6)	(215.8)	(361.5)
HH income	0.0922***	0.0909***	0.0912***	0.0934***	0.0936***
	(0.0103)	(0.0105)	(0.0104)	(0.0104)	(0.0104)
HH income sqr.	-9.06e-08***	-8.70e-08***	-8.83e-08***	-9.11e-08***	-9.23e-08***
	(1.74E-08)	(1.86E-08)	(1.80E-08)	(1.82E-08)	(1.75E-08)
Female head of HH dummy	-1034.2*	-1257.7**	-1086.2*	-1214.5**	-1040.0*
	(439.9)	(441.8)	(439.9)	(439.0)	(437.2)
Age of HH head	395.3***	459.1***	402.1***	456.7***	398.4***
	(68.05)	(67.29)	(67.94)	(67.08)	(67.72)
Age of HH head sqr.	-3.398***	-4.100***	-3.556***	-4.000***	-3.444***
	(0.694)	(0.685)	(0.692)	(0.683)	(0.689)
Outside food exp.	-0.690***	-0.692***	-0.696***	-0.681***	-0.685***
	(0.0944)	(0.0953)	(0.0949)	(0.0948)	(0.0944)
Outside food exp. sqr.	0.0000116**	0.0000113**	0.0000112**	0.0000115**	0.0000114**
	(4E-06)	(4E-06)	(4E-06)	(4E-06)	(4E-06)
Total HH hours worked	12.67*	21.20***	15.06**	20.34***	14.08*
	(5.758)	(5.538)	(5.752)	(5.517)	(5.733)
Total HH repair hours	77.42**	79.51**	72.31**	81.31**	73.91**
	(27.6)	(27.75)	(27.73)	(27.56)	(27.53)
Total HH housework hours	56.23***	58.96***	57.00***	57.78***	55.75***
	(9.502)	(9.452)	(9.486)	(9.414)	(9.449)
Total HH liked hours	14.18**	22.73***	16.60**	20.80***	14.52**
	(5.114)	(4.915)	(5.104)	(4.912)	(5.101)
HH members w/ health probs	1471.5***	1438.6***	1475.2***	1397.8***	1434.7***
	(208.3)	(208.1)	(207)	(208.0)	(207.0)
Constant term	3679.7	3205.6	4286.2	700.3	1764.3
	(2210.5)	(2209.4)	(2193.9)	(2206.2)	(2193.0)
Diconsa		x	x	x	x
CONAPO controls	X	x	x	x	x
Locality size controls	X	x	x	x	x
Demographic controls	X		x		x
Food freq. controls	X			x	x
# Observations	24555	24555	24555	24555	24555
adj. R-sq	0.153	0.156	0.157	0.161	0.162

14 ***significant at >0.1% ** significant at >1% * significant at >5% (standard errors in paretheses)

The coefficients of the remaining variables are also informative with regard to the determinants of total nutrition intake. Total household population is understandably significant and positive. The linear income term is significant and positive in the standard model, as expected, while the opposite sign and significance of the squared term suggests that THN levels out at a certain level of income as the household surpasses the subsistence threshold. Solving for income at the maximum of the quadratic function gives a value roughly equal to the maximum income in the sample – caloric intake is a concave function of income. The signs and significance of the linear and squared terms of the age of the head of household imply that, in terms of securing a sufficiently nutritious diet for household members, an older household head is important up to a certain point. Outside food expenditure is significant, and negative, with the coefficient on the linear variable suggesting a relatively poor calorie-to-peso ratio for outside food expenditure of 9.5 (deflated from quarterly to weekly expenditure) for the sample as a whole. The household activity hours are all positive and significant in varying degrees, with housework and 'liked activity' hours being the most important determinants. As mentioned previously, however, these regressors are possibly endogenous. The same can be said for the number of people with health problems in the household, given that it is significant and positive. The food purchase frequency controls are intended to account for the difficulties in accurately capturing the typical THN of all households in a week-long survey, as the true THN for those households making only monthly food purchases, for example, is likely to be more than what is recorded during this short time frame. Over the entire sample, however, it is statistically reasonable to assume this effect will be cancelled out.

4.3 PSM matching

In the first stage of the PSM method, as outlined in the methodology section, a propensity score function is estimated using, in this case, a probit regression. The results of this regression can be found in Appendix **IV**. The set of X regressors from the previous OLS regression is modified so that the balancing property may be satisfied, and the pseudo R2 value suggests that 31% of the variation in assignment to Diconsa treatment is explained. The mean p-score for the treatment group is 0.21 and 0.04 for the non-treated group. The results of the PSM estimation of the ATT are displayed below in **Table 3**.

Table 3. PSM ATT estimates (per week) with ENIGH 2010

Method	Treat	Control	(Calories)	Std. Err.	t-stat
No Diconsa	1288	3378	**9246.442**	3173.1	2.914
Strat	1288	22451	**13062.92**	1721.221	7.589
No outside food	946	11983	**14069.37**	2003.873	7.021
No Diconsa	1584	5172	**10564.26**	2484.089	4.253
Kernel	1584	26071	**13560.8**	1883.982	7.198
No outside food	1177	14518	**14191.14**	2107.935	6.732
No Diconsa	1584	1054	**8846.472**	2346.252	4.931
NN	1584	4478	**12977.23**	1730.454	7.499
No outside food	1177	3136	**10235.77**	2075.809	4.931

Using three different matching algorithms (Kernel, Nearest Neighbour and Stratification) to add robustness to the results, it appears the ATT as estimated by PSM over the full sample is similar to that obtained by simple OLS. That is, compared to the control group as identified by the propensity score, those households which purchase subsidised food commodities from Diconsa outlets seem on the whole to have a diet which is much higher in energy content, with a low estimate of 12,977 per household per week (411 added calories per person per day), and a high estimate of 13,561 (430 added calories per person per day). Assuming unconfoundedness of pre-treatment outcomes, this result stands in marked contrast to the results of the previously reviewed studies by Kochar (2005), Cunha (2010) and Jensen & Miller (2008a), and implies that the Diconsa subsidies do in fact impart significant nutritional benefits to those who participate. However, a note of caution in interpreting these estimates must be introduced here, for reasons explained shortly.

As a robustness check, two further PSM estimations are carried out on restricted samples consisting of a) only households with no outside food expenditure and b) only Diconsa households and households in municipalities with no Diconsa store. The latter restriction is made possible by utilizing the INEGI dataset on municipality services (INEGI, 2009, 2007). Restriction a) is intended to minimize the possible effect of hidden calorie consumption in outside food expenditure, which might distort the estimate if the outside food expenditure of Diconsa households is on average less than the control group. Restriction b) is intended to reinforce the unconfoundedness of pre-treatment outcomes by confining the control candidates to those households which are exogenously deprived of Diconsa treatment, rather than possibly voluntarily declining it. Restriction a) actually causes the ATT estimates to marginally increase in the case of the stratification and kernel matching methods, while restriction b) causes a slight decrease, particularly using the stratification matching technique. This is possibly because of unobservables present in the full sample, making it conceivable that the vector of matching variables X cannot fully account for differences in THN. If this is the case, one would expect households in areas with no Diconsa store to be better off in general, and analysis of the survey data does indeed show that the vast majority (83%) of municipalities with no Diconsa store are in the 'very low marginalisation' category. Even the low estimate with the b) restriction, however, equates to an increase of 280 calories per person per day. Results are also robust to varying specifications of the propensity score function as well as the alternative treatment variables described above.

One important advantage of using the PSM method in this analysis was the construction of a control group within the sample which serves to compare consumption behaviour. This control group was defined a) as all non-treatment households matched to Diconsa households using the nearest neighbour matching method and b) as a group of 3,365 non-treatment households gathered around the mean propensity score of Diconsa households. In the analysis that follows there is no significant qualitative difference in results between these two definitions of the control group.

Figure 6 below depicts the food baskets, in terms of expenditure, of the Diconsa and control groups. Overall, the differences in expenditure by food category are minor, with the most noticeable being the shift from expenditure on meat to cereals. It is worth stating here that overall food expenditure for the control and treatment groups is almost identical, with a statistically insignificant mean difference of 85 cents per week extra in the case of the Diconsa group households. The effect of treatment on food's share of expenditure – obtained as an outcome variable from PSM – is statistically nil, with both the control and treatment groups spending approximately 50% of their available income on food. This result contrasts with that of Tritah (2004), who found a significant increase in food share for households 'treated' by PDS Fair Price Shops in India.

Figure 6. Food expenditure – Diconsa versus Control

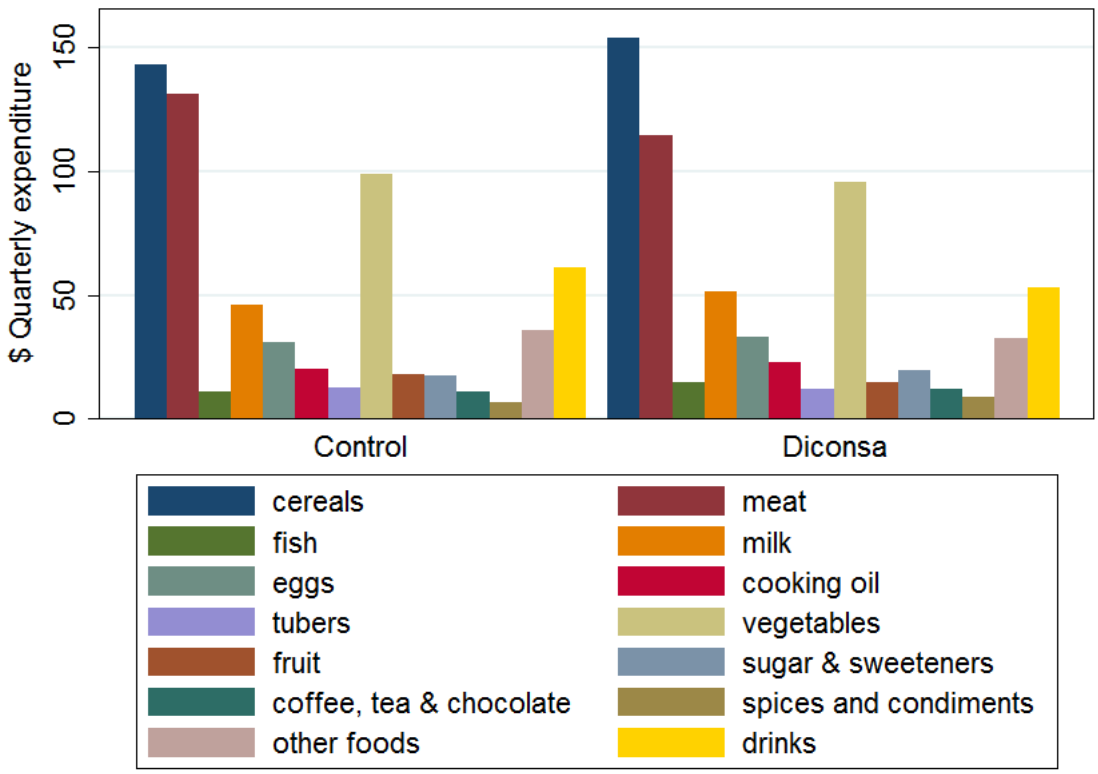


Figure 7 shows the difference in the caloric composition of the food baskets in the treatment and control groups. Once again, differences are relatively minor, with the important exception of the calorie share of cereals, which increases markedly in the Diconsa group. Subtracting the Diconsa calorie basket from that of the control, shown in **Figure 8**, allows us to see exactly where the extra calories are coming from. Interestingly, the majority of differences are minor, although likely greater in terms of other nutrients. The important exception is cereals, which accounts for

~10,000 extra calories per household per week, with cooking oils also bringing in a minor proportion of the extra calories. The universally positive calorie count of the different foods in the difference basket suggests that there may be substantial income as well as substitution effects. To investigate further, the savings, in terms of calorie per peso, of the Diconsa basket versus the market were calculated. These results are displayed in **Figure 9**. Prices in this case are calculated as (calorie count)/expenditure on each specific item, with the price per food category being a sum of expenditure-share-weighted prices from all items in that category. Both Diconsa and market prices are meaned at the municipal level. As we can see, while there appear to be substantial savings versus the market in the case of cereals and sugar & sweeteners, differences in other categories are minor or even negative in the case of fruit and other foods. Thus the increase in consumption (in caloric terms) of all categories cannot be solely explained

Figure 7. Calorie baskets – Diconsa versus Control (source: author's calculations)

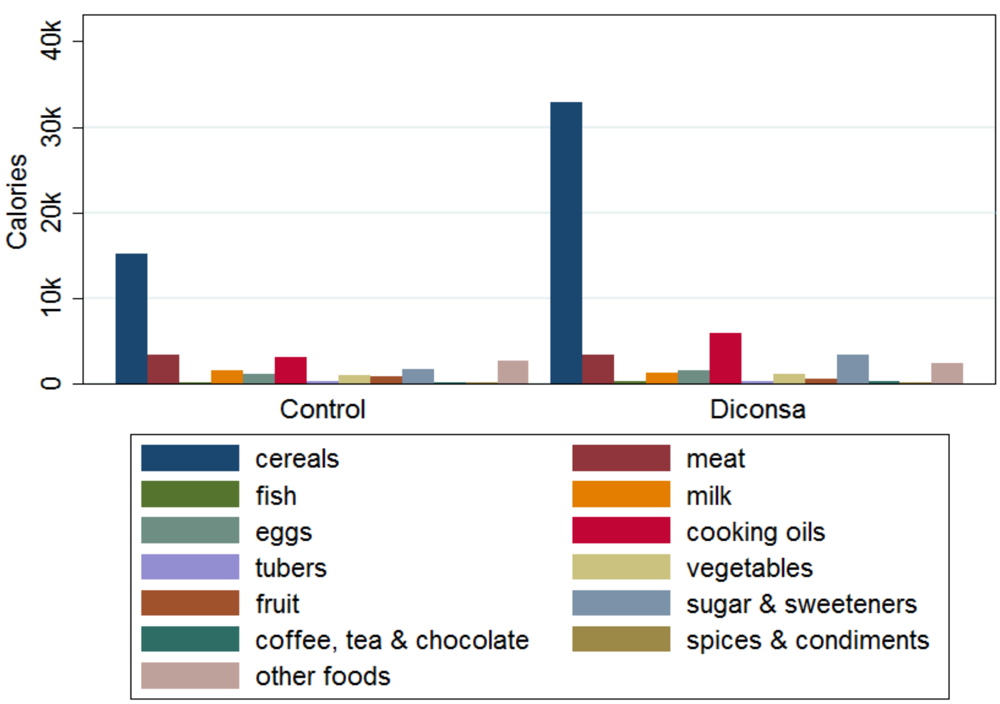


Figure 8. Difference in Calorie Basket – Diconsa vs Control[15]

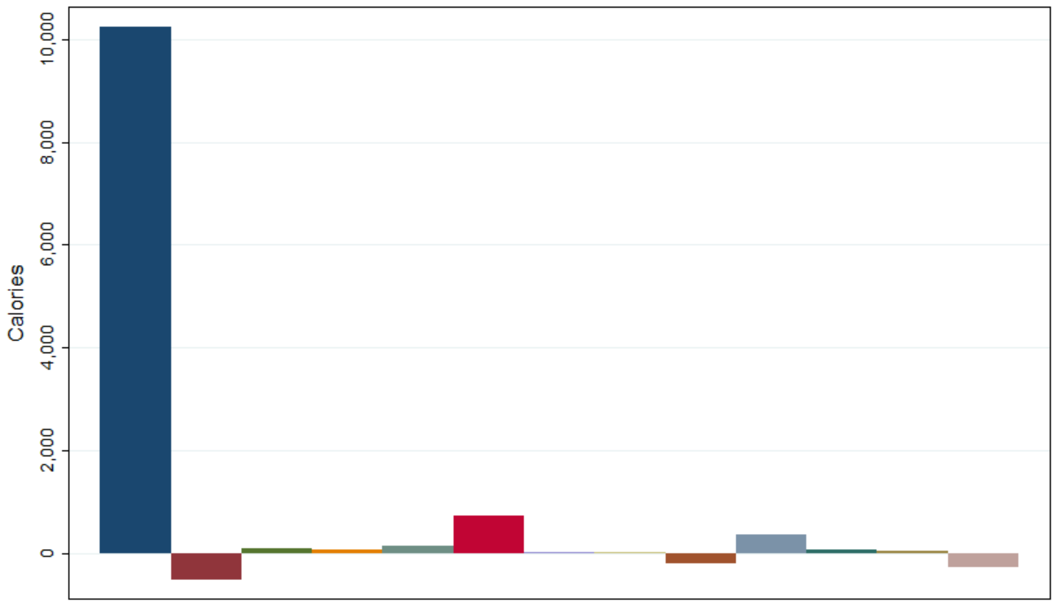
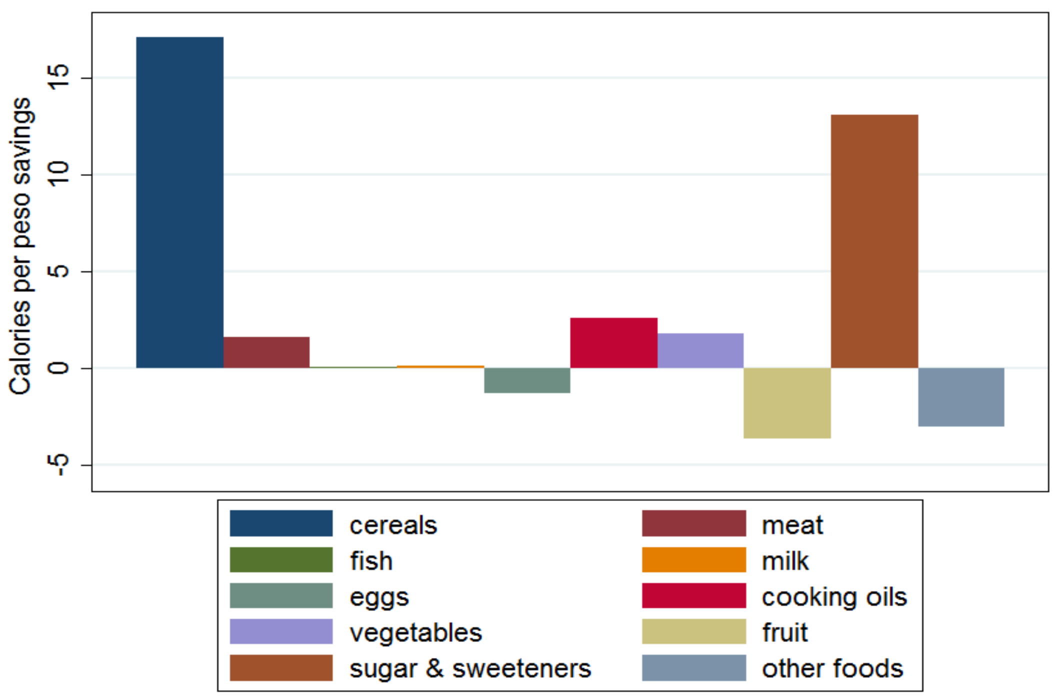


Figure 9. Calorie per peso savings – Diconsa versus market



[15] See product key for Figure 10

by own-price (calorie-per-peso) effects, but must be explained in terms of an interaction between substitution and (significant) income effects.

Comparing calorie-per-peso values of different food groups versus the same measure for the market is inherently problematic, however, given the fact that the composition of each category – in terms of specific items – is a quality choice on the part of the consumer and is unlikely to be based solely on relative caloric benefit. A basket that consists entirely of sweet wheat cakes, for example, is likely to have a much lower calorie-per-peso value than one that is composed only of raw corn grain. Thus the saving estimates are most likely somewhat overstated. To attempt to minimize this distortion, the savings versus the market of the 14 most frequent Diconsa purchases, in terms of specific items, were calculated in a similar fashion. These are displayed in **Figure 10**.

Restricting ourselves to these specific items, it appears that the most highly subsidised food stuff is actually crisps (chips), although given the varying quality and range of brands available, this is quite likely to be a quality choice rather than a true reflection of the savings margin. Apart from crisps, there is a significant savings margin for calorie-dense products like raw corn grain, wheat flour and sweet bread. Considering the relative homogeneity of these products as obtained from different sources (with the possible exception of sweet bread), this can be taken as a more accurate estimate of the true savings margin. The increased calorie intake of the Diconsa households, however, depends on the consumer response to these savings, i.e. the interaction between the savings margin and consumer demand for the different products. Looking at **Figure 11**, which displays the specific-item calorie basket of the Diconsa and control group, it is apparent that Diconsa households substitute heavily towards corn grain and (to a lesser extent) corn flour, while reducing their intake of corn tortilla. Thus it appears that the savings margin inducing the most significant consumer response amongst the treatment households is that on corn grain, with various interactions between income and substitution effects accounting for the remaining basket changes. In fact (**Figure 7**), almost the entire caloric value of the Diconsa food basket is provided by cereals, in particular (**Figure 11**) raw corn grain.

These are interesting results. Firstly, it appears that the potential problem of income effects overriding substitution effects for net zero or negative effect on caloric intake, as identified by numerous authors (Cunha, 2010, Jensen & Miller, 2008a, Kochar, 2005), is not present here.

Figure 10. Specific savings – Diconsa vs market

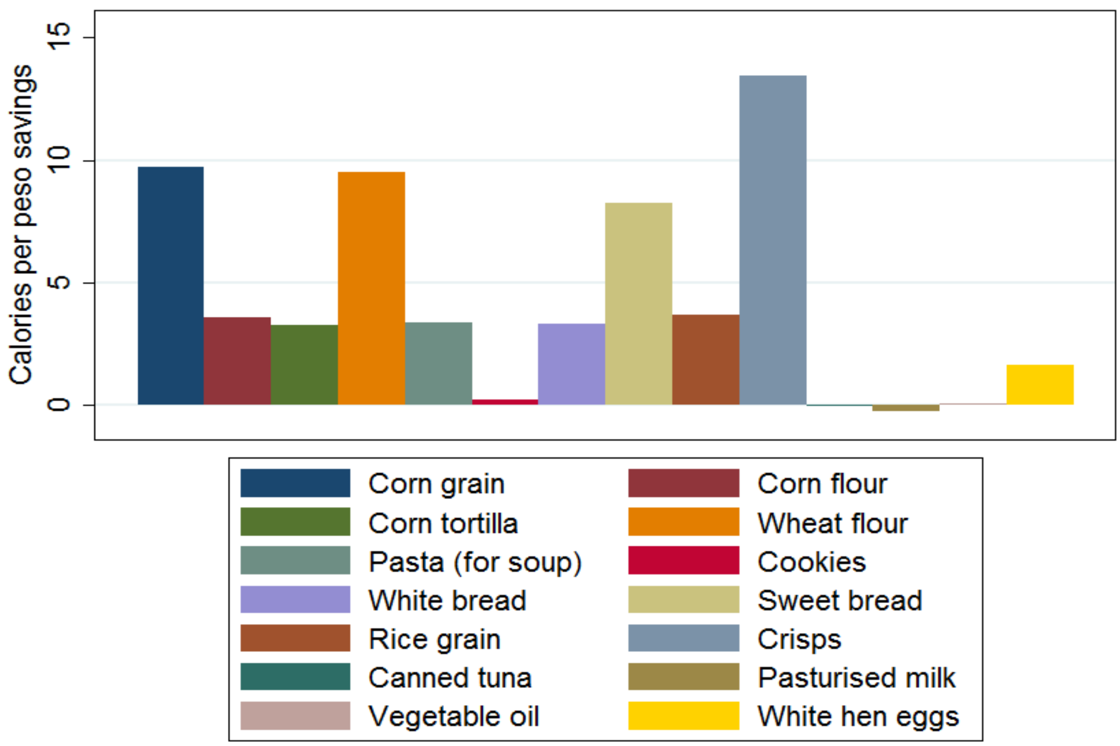
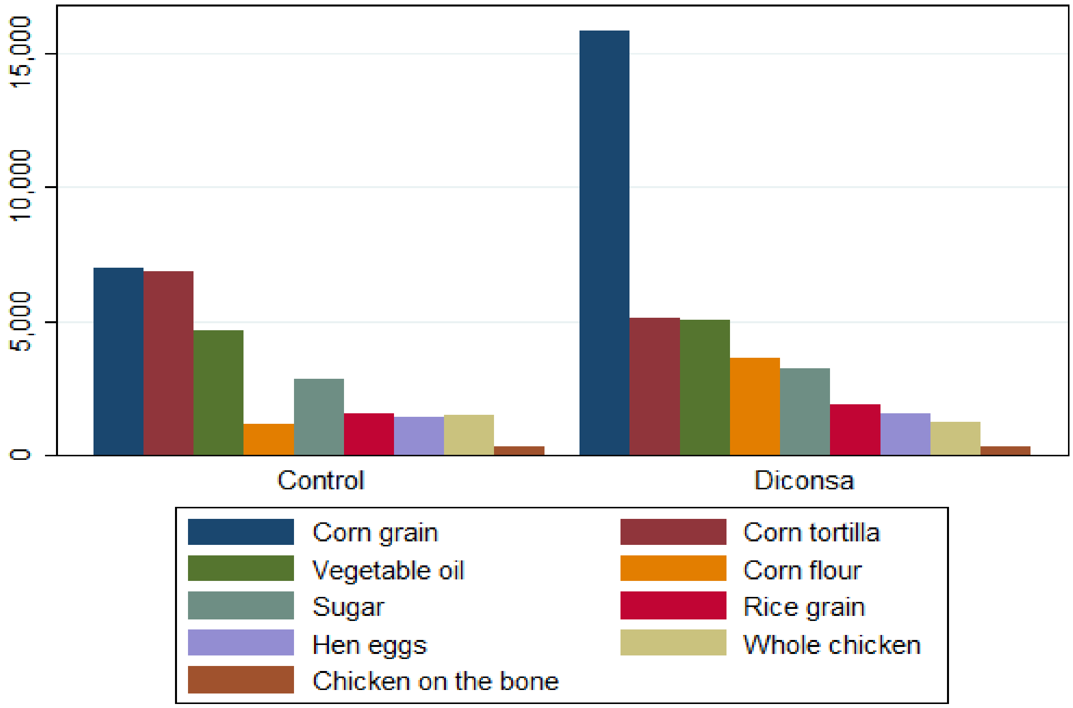


Figure 11. Specific calorie basket – Diconsa vs Control



If this result is not confounded, it appears that the pattern of food subsidies as provided by Diconsa is a successful subsidy framework for increasing household nutrition in terms of calories, without overly reducing intake of other nutrients. Thus the possible criticism directed against the subsidisation of basic staples that increased caloric intake results at the expense of other nutrients (Valdis, 1988, Cunha, 2010), does not appear to apply here. Once again, these conclusions are at least partly subject to certain assumptions about the accuracy of ATT in terms of actual consumption, which are tested by the more in-depth analysis to follow.

Further investigation into the increased consumption, or at least purchase, of raw corn grain by Diconsa households reveals further informative differences between households. Firstly, there is a total of only 309 households making raw corn grain purchases amongst the 1,564 Diconsa households. The mean purchase, in caloric terms, is 16,500 calories, significantly more than any other commodity. Thus it appears that the Diconsa households are purchasing corn grain in bulk quantities, and that the majority of the ATT estimate is being driven by these bulk purchases of a relatively small proportion of the treated households. Indeed, running the OLS and PSM estimations on a restricted sample including only those households which have made no corn grain purchases in the survey period, reduces the estimate of the ATT substantially to ~3164, although it remains significant. These estimates are displayed in **Table 4**.

Table 4. PSM estimates *without* corn grain households

Matching method	Treat	Control	**ATT (Calories)**	Std. Err.	t-stat
Strat	1052	21368	**3522.789**	869.848	4.05
Kernel	1275	24642	**3207.241**	792.847	4.045
NN	1275	4143	**3162.431**	1062.391	2.977

There are two possible interpretations of these new estimates:

a) Diconsa households restrict their purchases of corn to large bulk quantities, made infrequently, most likely because of the non-perishable nature of the foodstuff. Thus the week long survey has recorded these purchases only from those Diconsa households who have made these bulk purchases within the survey period. If true, this would not confound the estimate of the ATT, as the proportion of households making these purchases within the time frame would be expected to correspond to the frequency with which these purchases are made.

b) These bulk purchases of corn grain are intended for resale, rather than consumption by the household. This is a potentially major problem for the ATT estimate, as the measure of caloric intake could be heavily distorted by purchases not intended for consumption. Firstly, it is apparent that the Diconsa households which purchase grain are on average poorer than the Diconsa group as whole, with a mean of $4.61 dollars per person per day (DPPPD) versus $6.1 for the sample as a whole. Thus the ATT estimate at least for richer households is most likely overstated to some degree. Trimming the Diconsa group until the mean DPPPD corresponds to that of the corn grain households (dropping 440 observations), the mean caloric deficit per person is ~(- 560) calories per person per day – equating to a substantial surplus. This surplus is over twice that of even the richest quantile (>$20 DPPPD) which registers a mean surplus of ~(- 280). This suggests that the quantities of corn grain purchased are not explained entirely by household nutrition needs, and lends some support to the notion that at least some of the estimate is distorted by bulk corn purchases which are not intended for household consumption, most likely being sold on the black market.

The degree to which this reselling of subsidised commodities is carried out, and by which types of households is impossible to measure without improved data, and even then it would be extremely difficult, as any households surveyed are unlikely to willingly report, at least in exact detail, the reselling of subsidised corn grain to official sources. The fact that this evidence for reselling is present in the data despite the ENIGH survey questionnaire explicitly stating that all food expenditure recorded in the 7-day diaries should be for household consumption underlines this point. Additionally, as Diconsa stores are essentially privately or community owned stores supplied rather than operated by the government, there may be a lack of adequate monitoring or restrictions on bulk purchases. The implications for the estimate of the ATT at the household level (approaches one and two) are potentially serious. Although the ATT estimate obtained through matching without-corn-grain households is still significant (although substantially reduced) the possibility that reselling of other food types also occurs must be recognised, potentially rendering the ATT estimate obtained by analysis of household expenditure data trivial, or even nil. It would be pessimistic, however, to suppose that the entire calorie surplus, in all food groups, observed in Diconsa households is resold. At least some nutritional benefit at the household-level is thus cautiously hypothesised. There is certainly no evidence for the subsidies causing a net decreases in caloric intake, as found by Jensen & Miller (2008a).

4.4 Municipal-level OLS regressions

Given the potential problems with the ATT estimate obtained through the basic OLS and PSM approaches outlined above, the adapted municipal/locality level OLS regression is informative. As described in section **3.2.3**, the modified regression model was run on the augmented dataset consisting of the ENIGH 2010 & 2008 surveys. The results are displayed below in **Table 5.**

Table 5. OLS regression of THN of ENIGH 2010 & 2008[16]

		Total HH nutrition		
Diconsa adjusted		**9278.3****		
		(2879.4)		
Diconsa adj.*(V.high marg)			**12248.4***	**915.0**
			(5936.2)	(4097.8)
Diconsa adj.*(High marg)			**11368.7*****	**4802.8***
			(3334.9)	(2292.9)
Diconsa adj.*(Med marg)			**1842.9**	**3570.5**
			(2942.8)	(2523.0)
Diconsa adj.*(Low marg)			**7228.9**	**-11922.3**
			(6796.1)	(7293.2)
HH size	5104.3***	5068.8***	5069.3***	4468.8***
	(234.9)	(250.8)	(250.8)	(184.6)
HH income	0.0404***	0.0408***	0.0408***	0.0451***
	(0.00563)	(0.00661)	(0.00661)	(0.00694)
HH income sqr.	-1.22e-08***	-1.15e-08***	-1.15e-08***	-1.29e-08***
	(2.91e-09)	(2.41e-09)	(2.41e-09)	(2.64e-09)
Munip pop. Density	0.166**	0.313**	0.314**	0.319**
	(0.0598)	(0.118)	(0.118)	(0.121)
Outside food exp.	-0.610***	-0.581***	-0.581***	-0.619***
	(0.0759)	(0.0903)	(0.0903)	(0.0876)
Outside food exp. Sqr.	0.00000902*	0.00000872	0.00000873	0.00000889*
	(4E-06)	(4E-06)	(4E-06)	(4E-06)
Time dummy (1=2010)	740.4*	800.5*	760.6*	416.5
	(336.5)	(370.1)	(369.9)	(332.7)
Constant term	-1484361.7*	-1605174.1*	-1525079.5*	-830878.0
	(676287.4)	(743765.2)	(743447.6)	(668542.1)
Food purchase controls	X	X	x	x
Demographic controls	X	X	x	x
Locality size controls	X	X	x	x
CONAPO controls	X	X	x	x
Corn grain households	X	X	x	
N	51040	45568	45568	43103
adj. R-sq	0.154	0.149	0.149	0.196

16 ***significant at >0.1% **significant at >1% *significant at >5% (standard errors in parentheses)

Four models were run with standard errors clustered at the municipality level. The results are robust to various modifications of the regressor vector X as well as log-log and per capita specifications. A time dummy and a full set of CONAPO marginalisation index, demographic, food purchase frequency and locality size controls are included in each regression. Because there is an overall increase in caloric intake from 2008 to 2010, the total variation is absorbed in the large constant term. Overall, the results, in terms of an ATT estimate, appear to confirm those of the basic OLS and PSM approaches. The coefficient on the adjusted Diconsa treatment in the second model is significant at a ~0.1% level, while the coefficients on the (Diconsa adjusted x very highly marginalised dummy) and (Diconsa adjusted x highly marginalised) regressors are significant at the >5% and >0.1% level respectively. Given the definitions of treatment variables, the coefficient estimate for the adjusted Diconsa treatment is (very approximately) equivalent to the statement that a single Diconsa store in every rural locality across Mexico would increase average THN in the households in those locality/municipality subgroups by a mean 9278 calories per household per week, or ~290 calories per person per day, while the same calculation can theoretically be applied for rural localities in very highly or highly marginalised municipalities..

The fact that only households in very highly and highly marginalised areas – the target areas of the Diconsa program – retain significance in model 3 adds further support to the notion that this variation in THN – in <u>expenditure</u> terms - is at least primarily due to the presence or absence of a Diconsa store. Model 4, with all households purchasing corn grain in the survey period excluded, lends further support to this hypothesis, as the same decrease in ATT estimate is observed, becoming insignificant in the case of the very highly marginalised households. We have already observed the increased purchase of corn grain amongst Diconsa households, so this serves as a useful source of identification. The results of these municipal-level regressions also shed light on the possible reselling of corn grain by at least a minor subsample of the Diconsa treatment group. If this behaviour does indeed occur, it would appear that the reselling of grain occurs primarily within the same locality, or at least the same municipality. If the households were selling Diconsa purchased corn in different (better-off) municipalities or localities, one would expect the calorie increase to be distributed more evenly across the whole sample and thus the significance of the estimates would not be obtained in absence of sufficient correlation between the intensity of treatment variable and locality/municipality subgroups. If however, the Diconsa households are selling grain within the same geographic area, it appears to have, on average, a net positive effect on the caloric intake of all households in the area in question. If it is simply a case of the food markets in these areas being flooded with relatively cheap Diconsa grain, reflecting an overall increase in consumer demand, the Diconsa objective of increasing nutritional intake in the target areas has been achieved, albeit somewhat indirectly. The confinement of sales to the geographic area where the grain is purchased may be a result of the strategy of targeting remote rural locations, where the added opportunity cost of purchasing subsidised grain and then travelling to a better-off area to sell it might well be prohibitive. That said, the question of whether, assuming resale does occur, the households purchasing the extra grain are those most in need of the extra nutrition will remain an important one in need of further, more precise research.

One final point must be addressed with regard possible confounding factors. This is the matter of cross-coverage between the Diconsa program and a variety of other social safety-net programs also operated in Mexico, e.g. the previously mentioned *Opportunidades* and the PAL in-kind transfers. A possible criticism directed at this study could be that the ATT observed here, rather than being the consumer response to the particular pattern of subsidies in Diconsa stores, is actually the result of increased purchasing power of the Diconsa households who may be receiving greater a net income transfer than the control group once all other programs are taken into account. To address this objection, a conservative methodological approach suffices. This is as follows:

1) Find the mean value of total weekly transfers (in-kind and cash transfers from all sources) for the Diconsa and Control group and the observed difference between the two
2) Assume that *all* of the extra income is spent on Diconsa cereals, which were shown to have the maximum savings margin versus the market of ~17 calories per peso and thus estimate the maximum possible caloric increase resulting from the difference in transfers.

The maximum possible increase in calories, from the estimate obtained through this approach, is 833 calories per household per week, or roughly 6% of the total ATT. More detailed results can be found in Appendix **V.** Considering that this assumes all the extra income is spent on the most highly subsidised Diconsa products, it is likely a large overestimate of the possible proportion of the ATT accounted for by differences in other transfers. In the municipal-level case, regressing the peso value of transfers from different sources/programs (*Opportunidades*, etc) on the adjusted treatment variables reveals the correlation to be negative or insignificant for all sources except for Diconsa transfers, where a coefficient of 2.3 pesos is clearly not sufficient to overly distort the ATT estimate. Thus although it is conceivable that Diconsa households simply receive more transfers from other sources and use the extra income to purchase Diconsa products, even an extremely cautious estimate of the possible distorting effect reveals it to be minimal.

5) Conclusions

. This thesis has produced some original and informative results not only looking at overall nutritional effects, but also through a more in-depth investigation of how consumer behaviour in the targeted areas responds when offered the particular Diconsa pattern of food subsidies. The large increase in cereal consumption, driven primarily by bulk corn grain purchases, implies that the large savings margin prompts a significant consumer response. Specifically, the average Diconsa household food basket, as purchased, contains a greatly increased quantity of cereal products compared to the control households within the same total food expenditure bracket. In other food groups, the increases (and decreases) are minor or insignificant, which suggests that price effects of the subsidies are not overly detrimental in terms of the nutritional composition of the food basket as a whole. Overall, there appears to be strong evidence for some increase in caloric intake amongst the Diconsa households. This result stands in contrast to that of Cunha (2010), Kocha (2005) and Jensen and Miller (2008a), and suggests that this particular combination of geographic targeting and multiple, unrationed food subsidies appears to successfully overcome the problem of nutritionally-averse consumer response.

It is necessary to concede, however, that the question of whether this increase in quantities purchased translates *directly* into increased nutritional intake for the household members in question remains unresolved. This is primarily due to the suspect surplus in household caloric intake for a significant subsample of the Diconsa group, which can be taken as at least suggestive evidence that reselling of subsidised foods, in particular raw corn grain, occurs to some degree. This is one of the inherent difficulties in all analyses of household-level food consumption that rely on expenditure data rather than meticulously kept consumption diaries such as Jensen & Miller's randomised control trial in China (2008). On the other hand the results of the final OLS regression model with the augmented dataset allows some slightly more positive conclusions to be drawn in this regard. Firstly, the apparent increase in net nutrition intake that coincides with the establishment of a Diconsa outlet, particularly in areas of very high or high marginalisation, makes the argument that nutritional improvement is achieved in target areas a more persuasive one. The extent to which this holds true depends on exactly who constitutes the supplier and who constitutes the buyer in the grain resale market. Rogers (1988a) recognises that poorly targeted subsidy programs may suffer from the reselling of purchased commodities, but refers to the better-off selling to the worse-off. We observed, in the Diconsa sample, that the poorer households are more likely to purchase bulk quantities of grain greater than what would constitute the total nutritional requirements of the household, but that is not to say that the primary consumers of the resold commodities would be better-off households in general. Whether or not the Diconsa program is ideally targeted is not the primary motivation of this thesis, but the net welfare effects of black market sales of grain would depend on the homogeneity of the targeted areas. If there is a large market for cheap grain amongst the better-off households in these areas, then the poorer Diconsa households would be effectively converting their social transfer in food terms into extra income. If, on the other hand, these households are selling to relatively worse-off households who do not have access to the Diconsa subsidies for whatever reason, there is a targeting problem that needs to be addressed, although the nutritional outcomes overall could still be positive for the worse-off, or indeed both, types of households. In the former case (worse-off selling to better-off), although the additional income amounts to an increase in total utility for the selling households, the cost of establishing and maintaining the extensive Diconsa distribution network makes this an undesirable outcome, as the same transfer could be made in cash terms by various, generally simpler, mechanisms such a tax modifications or direct cash transfers. The point that the goals of overly complex social transfer systems that focus on in-kind transfers are often more efficiently achieved by direct cash transfers is well made by Cunha (2010) in his study of the PAL program in Mexico. Thus, if the majority of the extra nutrition contained in increased food purchases observed in this study is leaked to better-off households for whom food security is not an issue, a reform of the system – perhaps introducing weekly or monthly quotas - could be advisable. As the ENIGH dataset analysed in this thesis is not sufficient to answer this question conclusively, it is identified as a potentially important area for economic policy research.

With recent food price spikes around the world, ensuring food security for the very poorest has become an increasingly important policy issue in many developing countries (Lustig, 2009). Identifying exactly what overall welfare effects result for the poor is a very complex matter consisting of many different economic interactions on the macro and micro scale. What is certain, however, is that there will be significant social groups, in particular poor net buyers of staple foods, that will face serious problems in securing enough food to meet basic nutritional requirements. The typical health problems which result, particularly for children and those with pre-existing diseases like HIV, are well documented (WHO, 2003) and the social and economic consequences of widespread malnutrition should be underestimated. Therein lies the reason for the elevation of food by many to more than just a basic commodity to be bought and sold: it is considered a merit good, or even a fundamental right (Valdis, 1988). In the foreseeable future, governments around the world are thus destined to be concerned with designing, implementing and evaluating various policies intended to ensure that those most in need are consistently able to secure enough food for basic subsistence without going undernourished. There are many possible forms that these safety nets can take – food for work, food for education, conditional and unconditional cash transfers, in-kind transfers, food stamp programs, school nutrition programs etc. – and the relative costs and benefits of each must be carefully considered in order that the problem is addressed in an effective manner as often as possible. This thesis has been an attempt to better illuminate the relative merits of a particular example of a certain type of food safety net – food subsidisation – so that those who make those difficult policy decisions hopefully might be slightly better informed. The Diconsa program is not unique in most respects, and assuming consumer behaviour with regard to food demand follows some basic laws, the results found here can be applied elsewhere. That is, the Diconsa strategy of subsidising multiple, unrationed staple foods in rural, highly marginalised areas can potentially a) increase purchases of the subsidised staple food significantly, without overly detrimental substitution away from other food groups b) significantly increase caloric intake in the targeted area and c) result in leakages through the reselling of subsidised commodities. Although this particular field of economic policy is in need of much further research, it is hoped that the analysis contained in this thesis represents at least a minor contribution.

6) *Bibliography*

Literature

Agricultural Resource Marketing Centre, "White Corn Profile", 2011 (Available at: http://www.agmrc.org/commodities__products/grains__oilseeds/corn_grain/white_corn_profile.cfm)

Andreyeva, T., Long, M.W., and Brownell, K.D. "The Impact of Food Prices on Consumption: A Systematic Review of Research on the Price Elasticity of Demand for Food",American Journal of Public Health, Vol 100, No. 2, 2010

Becker, S.O. and Inchino. A., "Estimation of Average Treatment Effects based on Propensity Scores." The Stata Journal 2(4):358-377, 2002

Blundell, R. and Costa Dias, M., "Alternative approaches to evaluation in empirical microeconomics", The Institute for Fiscal Studies, Department of Economics, UCL, 2008

Conniffe, D., Gash, V. and O'Connell, P.J., "Evaluating State Programmes: "Natural Experiments" and Propensity Scores", The Economic and Social Review, Vol. 31, No. 4, October, pp. 283-308, 2000

Cunha, J.M., "Testing Paternalism: Cash vs. In-kind Transfer in Rural Mexico". Stanford University, 2010

Diconsa, *Directorio de Tiendas*, 2010

Food and Agriculture Organisation (FAO), World Food Price index, 2012 (Available at: http://www.fao.org/worldfoodsituation/ wfshome/foodpricesindex/en/)

Fox, J. A., "Accountability Politics: Power and Voice in Rural Mexico**",** Oxford 2007

French, S.A, "Pricing Effects on Food Choices", Division of Epidemiology, School of Public Health, University of Minnesota, Minneapolis, American Society for Nutritional Sciences, 2003

George, P.S., "Costs and Benefits of Food Subsidies in India" in *Food Subsidies in Developing Countries: Costs, Benefits, and Policy Options,* Per Pinstrup-Andersen (ed.) John Hopkins Press, 1988

Gundersen, C., Yañez, M., Valdez, C. and Kuhn, B., "A Comparison of Food Assistance Programs in Mexico and the United States" Food Assistance and Nutrition Research Report No. 6., 2000

Hopkins, R.F., “Political Calculations in Subsidizing Food” in *Food Subsidies in Developing Countries: Costs, Benefits, and Policy Options,* Per Pinstrup-Andersen (ed.) John Hopkins Press, 1988

Iqbal, F., “Sustaining Gains in Povery Reduction in the Middle East and North Africa”, Orientations in Development Series, World Bank 2006, ch5, p57-70

Instituto de *Nutrición* de Centroamérica y Panamá (INCAP) and Organización Panamericana de la Salud (OPS), “Tabla de Composición de Alimentos de Centroamérica”, 2007

Instituto Nacional de Nutrición (INN), México, “Recomendaciones para el consumo de calorías, para individuos normales, con la dieta en las condiciones de México”, 1983

Jensen, R.T. and Miller, N.H, “Giffen Behavior: Theory and Evidence” Faculty Research Working Papers Series, Havard JFK School of Governance, 2007

Jensen, R.T. and Miller, N.H, “Do Consumer Price Subsidies Really Improve Nutrition?” CID Working Paper No. 160, 2008a

Jensen, R.T. and Miller, N.H., “Giffen Behavior and Subsistence Consumption “ (The American Economic Review, Vol. 98, No. 4, pp. 1553-1577, 2008b

Kochar, A., “Can Targeted Food Programs Improve Nutrition? An Empirical Analysis of India’s Public Distribution System” (Economic Development and Cultural Change, Vol. 54, No. 1, pp. 203-235, 2005

Kumar, S.K. and Alderman, H. “Food Consumption and Nutritional Effects of Consumer-Oriented Food Subsidies” in *Food Subsidies in Developing Countries: Costs, Benefits, and Policy Options,* Per Pinstrup-Andersen (ed.) John Hopkins Press, 1988

Lustig, N., “Coping with Rising Food Prices: Policy Dilemmas in the Developing World”, Working Paper Number 164, March 2009

McKenzie, D., “Are tortillas a Giffen Good in Mexico?” , Economics Bulletin, Vol. 15, No. 1 pp. 1−7, 2002

Pinstrup-Andersen, P. "The Social and Economic Effects of Consumer-Oriented Food Subsidies: A Summary of Current Evidence" in *Food Subsidies in Developing Countries: Costs, Benefits, and Policy Options,* Per Pinstrup-Andersen (ed.) John Hopkins Press. 1988a

Pinstrup-Andersen, P.,“The Effectiveness of Consumer-Oriented Food Subsidies in Reaching Rationing and Income Transfer Goals” in *Food Subsidies in Developing Countries: Costs, Benefits, and Policy Options,* Per Pinstrup-Andersen (ed.) John Hopkins Press. 1988b

Pufahl, A., Heinrich, J. and Weiss, C.R., "Evaluating the effects of farm programmes results from propensity score matching", European Review of Agricultural Economics Vol 36 (1), pp. 79–101, 2009

Rogers, B.L., "Design and Implementation Considerations for Consumer-Oriented Food Subsidies" in *Food Subsidies in Developing Countries: Costs, Benefits, and Policy Options,* Per Pinstrup-Andersen (ed.) John Hopkins Press, 1988a

Rogers, B.L., "Pakistan's Ration System: Distribution of Costs and Benefits:" in *Food Subsidies in Developing Countries: Costs, Benefits, and Policy Options,* Per Pinstrup-Andersen (ed.) John Hopkins Press. 1988b

Senauer, B. "Household behaviour and nutrition in developing countries" in *Food Policy*, vol. 15, issue 5, pages 408-417, 1990

Tritah, A., "The Public Distribution System in India: Counting the poor from making the poor count" GREMAQ, Universit´e des Sciences Sociales, Toulouse, France, 2004

Universidad Autónoma Chapingo (authors not cited), "Evaluación Externa Programa de Abasto Rural, Diconsa 2006", Universidad Autónoma Chapingo, Unidad Gestora de Servicios Tecnológicos, 2007

Valdis, A. "Explicit versus Implicit Food Subsidies: Distribution of Costs" in *Food Subsidies in Developing Countries: Costs, Benefits, and Policy Options,* Per Pinstrup-Andersen (ed.) John Hopkins Press, 1988

Victor, C., "The Role Of Diconsa In Promoting Food Security In Rural Mexico And Providing Assistance In Case Of Natural Disasters " p121-152 "Border Lines: Journal of the Latino Research Centre", Vol V (Special Edition), 2011

Wood, B., Nelson, C., Nogueria, L., "Measuring the Welfare Impact of Food Price Increases on Mexican Households", University of Illinois at Urbana-Champaign, 2010

World Health Organization (Joint WHO/FAO Expert Consultation), "Diet, Nutrition and The Prevention Of Chronic Diseases", WHO Technical Report Series, World Health Organization Geneva, 2002

Xuguang, G., Popkin, B.M., Mroz, T.A. and Fengying, Z., "Food Price Policy Can Favorably Alter Macronutrient Intake in China", The Journal of Nutrition, Community and International Nutrition, 1999

Zazaig, S.M & Adams, R.H., "The Egyptian Food Subsidy System: Operation and Effects on Income Distribution", World Development Vol. 24, No. 11, pp. 1777-1791, Elsevier Science Ltd, 1996

Data

Instituto Nacional de Estadística y Geografía (INEGI) in Mexico,

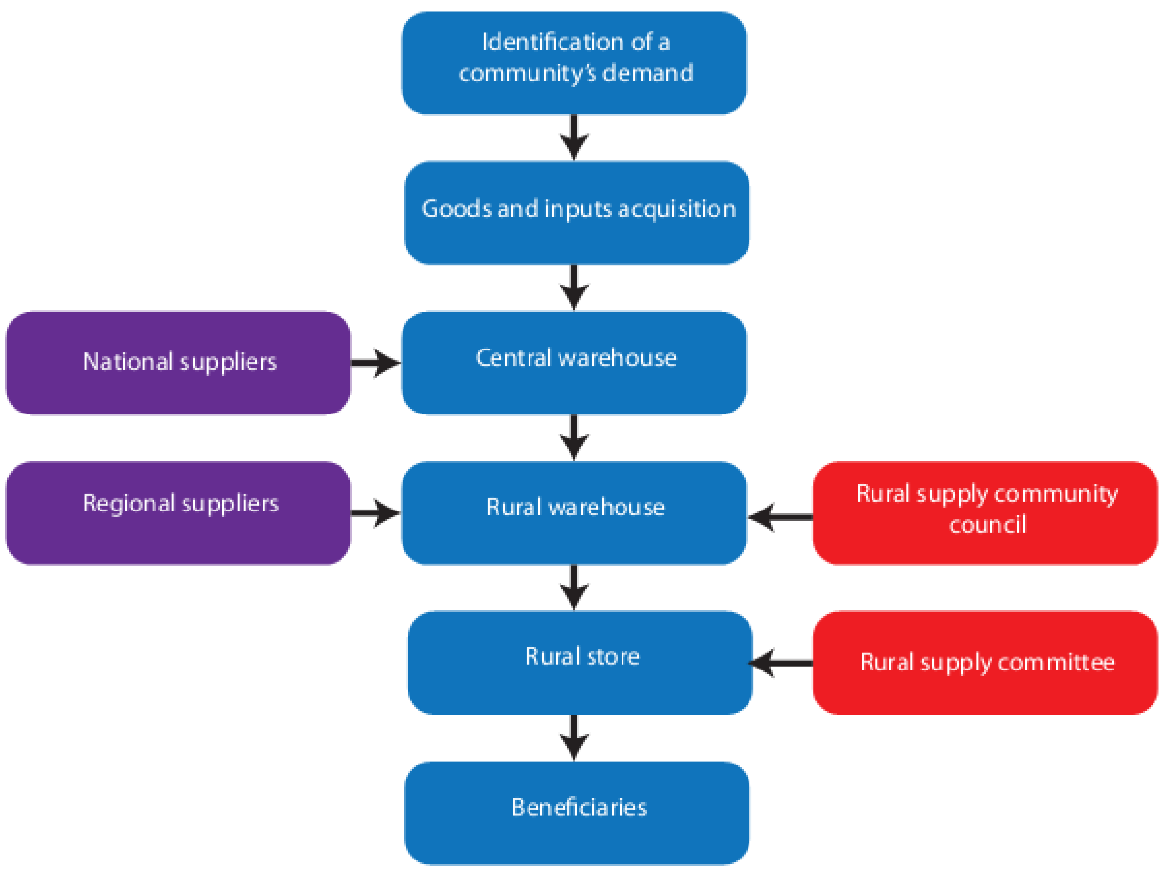
- Encuesta Nacional de Ingresos y Gastos 2010 & 2008
- Encuesta Nacional de Gobierno, Seguridad Pública y Justicia Municipal 2009 & 2007

7) Appendix

Appendix I. Diconsa's 'Basic Basket' (source: Diconsa, cited by Chora, V., 2011, p135)

1. Corn	8. Powdered milk	15. Corn flour
2. Beans	9. Powdered chocolate	16. Wheat flour
3. Rice	10. Instant coffee	17. Cookies
4. Sugar	11. Tuna fish	18. Washing powder
5. Vegetable oil	12. Sardines	19. Toilet paper
6. Pasta	13. Vegetable shortening	20. Soap
7. Canned green peppers	14. Salt	21. Washing soap

Appendix II. Diconsa's Distribution Process (source: Diconsa, cited by Chora, V., 2011, p137)



Appendix III. Calorie requirements per day by sex & age

(source: Instituto Nacional de Nutrición (INN), México 1983)

	Calories
Children	
<3 years	1000
2-3 years	1000
4-6 years	1500
7-10 years	2000
Male	
11-13 years	2500
14-18 years	3000
18-34 years	2750
35-54 years	2500
>55 years	2250
Female	
11-18 years	2300
18-34 years	2000
35-54 years	1850
>55 years	1700

Appendix IV. Probit regression for p-score. (source: author's calculations)

	Diconsa dummy
Large town dummy	0.144
	(0.0804)
Small town dummy	0.788***
	(0.0725)
Rural dummy	1.297***
	(0.0686)
Detached toilet dummy	-0.0627
	(0.0550)
Air conditioning dummy	-0.125
	(0.0770)
Energy exp.	-0.0000768**
	(0.0000260)
# Literate HH members	0.120
	(0.110)
# HH members in school	-0.00471
	(0.0478)
Public transport exp.	-0.0000249*
	(0.0000123)
# Employed HH members	0.0382*
	(0.0150)
2 floors dummy	-0.109
	(0.0624)
3 floors dummy	-0.0732
	(0.0786)
Water access type 1 dummy	0.00498
	(0.0457)
Water access type 2 dummy	0.123*
	(0.0554)
Water pump dummy	0.104*
	(0.0523)
# Rooms	0.00114
	(0.0131)
CONAPO 1 dummy	0.288***
	(0.0743)

CONAPO 2 dummy	0.398***
	(0.0613)
CONAPO 3 dummy	0.169**
	(0.0617)
CONAPO 4 dummy	-0.0161
	(0.0648)
Family type 1 dummy	0.0730
	(0.0962)
Family type 2 dummy	0.0436
	(0.106)
Family type 3 dummy	-0.405
	(0.315)
Family type 4 dummy	0.296
	(0.371)
Microwave dummy	0.00396
	(0.0464)
Toaster dummy	0.115
	(0.0744)
HH income	-0.00000250
	(0.00000135)
HH income sqr.	2.48e-12
	(2.37e-12)
Monthly food purchases dummy	-0.00379
	(0.0639)
Bi-monthly food purchases dummy	0.0594
	(0.0488)
Weekly food purchases dummy	0.0724
	(0.0420)
Bi-weekly food purchases dummy	0.0533
	(0.0800)
Daily food purchases dummy	0.0660
	(0.0402)
TV dummy	-0.183***
	(0.0500)
Indigenous dummy	0.101*
	(0.0433)
Demographics (caloric need)	0.0000144
	(0.0000130)
HH size	-0.0234

	(0.0314)
# Hours worked	-0.00327*
	(0.00159)
# Hours repairing	0.0140
	(0.00753)
# Hours housework	0.00204
	(0.00258)
Extra work hours	-0.00000480
	(0.0000299)
% of income from agriculture	0.392**
	(0.150)
Outside food exp.	-0.000103
	(0.0000821)
Mean HH age	0.0000427
	(0.00251)
HH education level	-0.0408
	(0.0211)
Age of HH head sqr.	0.00000848
	(0.0000198)
Constant term	-2.274***
	(0.220)
N	23739
Pseudo. R-sq	0.31

***significant at >0.1% **significant at >1% *significant at >5%

(Standard errors in parentheses)

Appendix V. Calculation of max transfers component of ATT (source: author's calculations)

	#Obs	Mean	Std. Dev.	Min	Max
Total transfers per week (DICONSA)	1564	362.0132	554.7855	0	7932.806
Total tranfers per week (CONTROL)	3354	313.0385	493.4052	0	10864.83
Difference		49			
Possible calorie increase (x17)		**833**			